Chlorinated paraffins with carbon chain lengths in the range C14–17 and chlorination levels at or exceeding 45 per cent chlorine by weight

Draft risk management evaluation

Second Draft

09 March 2023

Table of Contents

Note to Reader on the Second Draft:

The drafter recognises that the draft in its current form is longer than specified by the Secretariat for a risk management evaluation. In the subsequent draft, the document will be shortened, for example by moving sections of text or data to a separate INF document. The drafter welcomes comments and suggestions from Parties and Observers on ways to shorten the document.

Executive Summary

1. [To include in subsequent draft]

1 Introduction

1.1 Chemical Identity

2. Polychlorinated n-alkanes, also known as chlorinated paraffins (CPs), are a family of complex industrial chemicals with different degrees of chlorination and chain length distributions depending on the application and feedstock. This risk management evaluation focusses on any CP that has constituents with 14 to 17 carbon atoms (C_{14-17}) and chlorination levels at or exceeding 45% chlorine by weight. These congeners are the principal constituents of substances called “medium-chain chlorinated paraffins” (MCCPs) in Europe, North America and Australia, and major constituents of several products manufactured in Asia (e.g., CP-52) (see UNEP/POPS/POPRC.18/5/Add.1). For purposes of this risk management evaluation (RME), the term “MCCPs” is used to refer to these congeners throughout the document.

3. A CP constituent is an individual structural isomer, i.e., chlorine atoms are in defined molecular positions on the carbon chain. Congeners are groups of isomers with the same structural formula such as $C_{14}Cl_5$, without the chlorine position being defined. CP homologues are groups of constituents with the same carbon chain length but varying number of chlorine atoms, e.g., the C_{14} homologue.

4. Due to the variation of levels of chlorination and positions where chlorine atoms sit on the carbon chain, MCCPs can contain many thousands of possible different constituents. Chain lengths below C_{14} are structurally analogous to short chain chlorinated paraffins (SCCPs), containing C_{10-13} carbon chain lengths), and chain lengths above C_{17} are structurally analogous to long chain chlorinated paraffins (LCCPs, containing C_{18-30} carbon chain lengths).

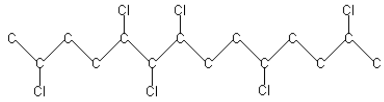
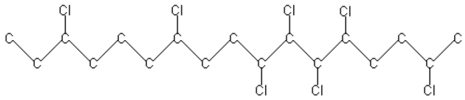
5. In this RME, a distinction is made between CPs (referring to the specific chemical substance/congener) and CP-containing products (the commercial product on the market). The chlorine content in commercially available CP products is usually between 40% and 63% by weight, with the majority of products containing chlorine content between 45% and 52% by weight. The chlorination process is random, and so all of these products contain many thousands of constituents (Yuan et al., 2020; Tomy et al., 1997)[1]. Therefore “MCCPs” is considered a substance of ‘Unknown or Variable composition, Complex reaction product or Biological material’ (UVCB). Therefore, naming conventions use the average level of chlorination and chain-length within the final produced mixture. Furthermore, specific constituents in the final mixture may be outside these ranges, albeit in very low concentrations.

6. Around 40 CAS numbers have been used to identify the whole chlorinated paraffin family. An indicative list of relevant CAS numbers is presented in the supplementary information accompanying the risk profile (UNEP/POPS/POPRC.18/INF/10). Key information for CPs with C_{14-17} chain lengths and chlorination levels at or exceeding 45% chlorine by weight, is provided in Table 1.1. Existing CAS numbers (e.g. 85535-85-9) do not define the level of chlorination by weight in the substance ‘Alkanes, C14-17, chloro’ . In practice this means that there may be several different commercial products, varying by chlorine content only, sold under the same CAS number.

Table 1.1 Information pertaining to the chemical identity of MCCPs

Common name IUPAC Chem. Abstracts	Medium chain chlorinated paraffins (MCCPs) *Alkanes C14-C17, Chloro*
Other names	Chlorinated paraffins, C_{14-17}
Molecular formula	$C_xH_{(2x-y+2)}Cl_y$, where x = 14 to 17 and y = ≥ 5 to 17
Molecular weight	370–826 g/mole (approximately)
CAS registry number	See UNEP/POPS/POPRC.18/11/Add.3
Trade names	Cereclor, Chlorinated Paraffin, Chlorinated paraffin liquid, grade XP-470 (liquid), grade XP-52 (liquid), chlorinated paraffins (CP-470), chlorinated paraffins (CP-52), Chloroparaffin, Chlorparafin, Electroclor, Essechlor, Hordaflex, Hordalub

[1] Tomy et al. (1997) includes a formula for the calculation of the number of isomers.

Structural formulas of the isomers	Example structures (hydrogen atoms removed for simplicity) include:  $C_{14}H_{24}Cl_6$  $C_{17}H_{29}Cl_7$

1.2 Conclusions of the Review Committee regarding Annex E information

7. At its eighteenth meeting (Rome 26-30 September 2022), the committee evaluated the risk profile for MCCPs in accordance with Annex E. The committee adopted the risk profile for MCCPs in decision POPRC-18/4 and:

(a) Decided, in accordance with paragraph 7(a) of Article 8 of the Convention, that chlorinated paraffins with carbon chain lengths in the range of C_{14-17} and chlorination levels at or exceeding 45% chlorine by weight are likely as a result of their long-range transport, to lead to significant adverse human health and/or environmental effects such that the global action is warranted.

(b) Also decided, in accordance with paragraph 7(a) of Article 8 of the Convention and paragraph 29 of the annex to decision SC-1/7 of the Conference of the Parties, to establish an intersessional working group to prepare a risk management evaluation that includes an analysis of possible control measures for chlorinated paraffins with carbon chain lengths in the range of C_{14-17} and chlorination levels at or exceeding 45% chlorine by weight in accordance with Annex F to the Convention.

(c) Invited Parties and observes to submit to the Secretariat the information specified in Annex F, in accordance with paragraph 7(a) of the Article 8 of the Convention, before 5 December 2022.

1.3 Data sources

8. The RME is primarily based on information that has been provided by Parties to the Convention and observers according to Annex F to the Convention. Information was submitted by the following[2]:

(a) Parties: Argentina, Canada, European Union (EU), Guatemala, Hungary, Japan, Norway, Oman, Qatar, Sweden, Saudi Arabia.

(b) Observers: International Coordinating Council of Aerospace Industries Associations (ICCAIA), World Chlorine Council (WCC), Chlorinated Paraffins Industry Association (CPIA), Alaska Community Action on Toxics (ACAT) and International Pollutants Elimination Network (IPEN)).

9. In addition, information has been used from open information sources as well as scientific literature (see the list of references). The following key references were used as a basis to develop the current document:

(c) Risk Profile for MCCPs (UNEP/POPS/POPRC.18/5/Add.1)

(d) Information submitted by parties and Observers according to Annex E

(e) European Chemicals Agency (ECHA) Annex XV Proposal for Identification of MCCPs as Substances of Very High Concern (SVHCs) and Annex XV Restriction Proposal reports and accompanying documents (ECHA, 2020, 2022).

(f) European Commission (2021) Study to support the review of the list of restricted substances and to assess a new exemption request under Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS)

(g) A review of key scientific literature, including a number of relatively recent publications, most notably the studies by Chen et al. (2021; 2022), Guida et al. (2020), and Glüge et al. (2018), have been cited in this RME

[2] Where Parties or Observers are indicated in [brackets], this indicates Parties that submitted information to Annex F after the 16th December 2022 and has not been included in this draft dossier. This information will be included in the next dossier draft.

and had previously been cited in the risk profile.

1.4 Status of the chemical under international conventions

10. MCCPs are currently not subject to any international conventions.

11. A decision[3] on the phase out of SCCPs was adopted by OSPAR (the Commission for the Protection of Marine Environment of the North-East Atlantic), in 1995. The OSPAR (2009) background document highlighted that MCCPs have been used as a replacement for SCCPs, but noted that MCCPs also pose an environmental risk, and risk reduction measures were required for some uses (OSPAR Commission 2009). It was concluded that in order to avoid substitution of SCCPs by alternatives which are later shown to be unacceptable, OSPAR Contracting Parties should take action to ensure that any decisions on substitution take account of the fact that the work in the EU risk assessment of MCCPs has demonstrated a need for risk reduction measures for some of the uses of MCCPs and that, in the light of the information collected on MCCPs and LCCPs by the UK (in its EU risk assessment of MCCPs) further consideration by OSPAR on the whole range of CPs is likely to be needed. OSPAR is therefore recommended to review the outcome of the EU Risk Assessment and the Risk Reduction Strategy for MCCPs.

1.5 Any national or regional control action taken[4]

12. In the EU, MCCPs (alkanes, $C_{14–17,}$ chloro; CAS No. 85535-85-9) were assessed under the Existing Substances Regulation (EC) No. 793/93 (EC 2005, EC, 2007, HSE 2008), and via a transitional Annex XV dossier under the REACH Regulation (Environment Agency, 2010). Subsequently, MCCPs underwent Substance Evaluation under REACH. It was concluded that MCCPs meet the REACH Annex XIII criteria for Persistent, Bioaccumulative and Toxic (PBT) and for very persistent, very Bioaccumulative (vPvB) properties (Environment Agency, 2019). "MCCPs" have been identified as substances of very high concern (SVHCs)[5], and a proposal to restrict "MCCPs"[6] in the EU was published in 2022 (ECHA, 2022).

13. Directive 2011/65/EU (RoHS 2) requires EU Member States to ensure that electrical and electronic equipment (EEE) does not contain the substances listed in Annex II in excess of the specified maximum tolerated value. In May 2022, following a technical assessment, the European Commission published an initiative proposing to add MCCPs to the list of restricted substances (Annex II)[7].

14. It is indicated that in Sweden, 90% of MCCPs and LCCPs have been phased out (OSPAR, 2009). While similar actions to reduce the use of CPs are indicated in other OSPAR nations (e.g. Finland, Netherlands, UK, Norway, Germany and Belgium) it is not clear if these have been directed specifically at MCCPs.

15. The Australian Department of Health published a hazard assessment of MCCPs in June 2020 (NICNAS, 2020). This report concluded that MCCPs meet Australia's domestic PBT criteria and that some congener groups might meet the Annex D screening criteria for POPs under the Stockholm Convention.

16. In Canada, an assessment of chlorinated alkanes, including MCCPs, published in 2008, concluded that MCCPs met the criteria for toxicity to the environment and human health, as set out in paragraphs 64 (a) and 64 (c) of the Canadian Environmental Protection Act, 1999. Following this assessment, and a 2012 update on the human health assessment of long-chain chlorinated alkanes, chlorinated alkanes containing 10-20 carbons have been added to the List of Toxic Substances in Schedule 1 to the Canadian Environmental Protection Act, 1999. Canada has also listed MCCPs on the National Pollutant Release Inventory (NPRI) under the category "Chlorinated alkanes, medium-chain, $C_nH_xCl_{(2n+2-x)}$, $14 \leq n \leq 17$", with an annual reporting threshold of 1000 kg at 1% concentration manufactured, processed, or otherwise used.". Federal Environmental Quality Guidelines (FEQGs) were published in 2016 for

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[3] Decision 95/1 PARCOM Decision 95/1 on the Phasing Out of Short Chained Chlorinated Paraffins

[4] This is non-exhaustive and only covers recent control actions taken.

[5] The EU SVHC listing for "MCCPs" was defined as UVCB substances consisting of more than or equal to 80% linear chloroalkanes with carbon chain lengths within the range from C_{14} to C_{17}

[6] The proposed EU REACH restriction covers the restricts the manufacturing of substances, the placing on the market of substances, mixtures and articles if the overall concentration of the chloroalkanes listed below is equal or greater than 0.1% wt.

'Linear chloroalkanes with the following molecular formulae: C14H30-yCly with y = 3 to 11; C15H32-yCly with y = 3 to 8; C16H34-yCly with y = 3 to 8; C17H36-yCly with y = 6 to 9'

[7] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13469-Hazardous-substances-in-electrical-and-electronic-equipment-list-of-restricted-substances-update-_en

chlorinated alkanes in water, sediment, fish tissue, and mammalian wildlife to protect aquatic life and non-human mammalian consumers of aquatic life. The aquatic FEQGs are applicable to both marine and freshwater.

17. In the United States of America (USA), the United States Environmental Protection Agency (US EPA) conducted a review in response to premanufacture notices (PMNs) submitted by manufacturers/importers of chloroalkane chemicals; the US EPA also made determinations regarding these notices approved in 2017. This was followed by a significant new use rule (SNUR) under the U.S. Toxic Substances Control Act (TSCA) issued in September 2019, indicating permitted uses/conditions for these chemicals. The US EPA concluded in the 2019 SNUR that these chloroalkanes "have been manufactured, processed and used for the uses described in the PMN[s] for more than 40 years; manufacture, processing, distribution in commerce, use and disposal of the PMN substances in accordance with the provisions of the TSCA section 5(e) order do not create an unreasonable risk of injury to health or the environment." (US EPA, 2019).

18. Guatemala (2022, Annex F submission) is reportedly currently considering several options to control imports and uses of CPs. To accomplish its risk reduction goals, this Party plans to identify the areas of consumption, develop a baseline survey and, evaluate different parameters in order to achieve management clarity for the elimination of this type of contaminant.

2 Summary information relevant to the risk management evaluation

2.1 Production, uses and emissions

Production

19. As discussed in the risk profile (UNEP/POPS/POPRC.18/11/Add.3), the commercial production of CPs started in the 1930s. Glüge et al. (2016) estimated that the global manufacture of CPs can be divided into three time periods: (i) 1935–1974: production volumes < 35,000 tonnes/year; (ii) 1975–2005: global CP production increased from 60,000 to 350,000 tonnes/year; (iii) 2006–2012: global CP production increased much more rapidly, up to 1.1 million tonnes (Mt). Limited data are available for the most recent decade, however modelling by Chen et al. (2022) suggests overall global production began to fall during this period[8]. The CP industry has indicated that production has been lower in recent years partly due to the global Covid-19 pandemic, which is reported to have influenced the operation of downstream rubber and plastic processing companies, for example in China (CCPIA pers. comm, 2022).

20. A recent study by Chen et al. (2022) developed global inventories of production, use, in-use stocks, and emissions of total CPs, including MCCPs using a dynamic substance flow analysis model[9] based on collected and curated historical production and trade data[10]. Based on this model, it is estimated that global cumulative production of MCCPs in the period 1930 to 2020 was ~18.5 Mt, with MCCPs constituting the majority (57%) of total global CPs production in that period (Chen et al., 2022). This substantial proportion of MCCPs in the total CP emissions has largely been attributed to MCCPs and LCCPs replacing SCCPs in their applications in the short- or medium-term following the listing of SCCPs under the Convention but could also be linked to the ban of other chemicals such as pentabromodiphenyl ethers (ECHA, 2022).

21. Based on the information presented in the risk profile, current global production of CPs with $C_{14–17}$ chain lengths could be in the region of 0.8 Mt per year. Peak global levels of production of MCCPs to date were estimated by Chen et al. (2022) to have been observed in around 2014, in the range of 0.75 Mt per year.

22. Based on performance evaluation and sensitivity analysis conducted on the model by Chen et al, (2022), it was noted by the authors that good agreement between modelled and measured data (considering the typical variability in the concentrations from environmental monitoring) indicated a satisfactory performance of the model in characterising the global anthropospheric fate of CPs. However, it was also noted that, to date, data on the regional and global production of CPs are still limited and incomplete, especially with respect to a breakdown of the total CP production into SCCPs, MCCPs, and LCCPs.

[8] Note to reader – unless stated otherwise, reference to tonnes refers to 'metric tonnes'

[9] The Chemical in Products Comprehensive Anthropospher Fate Estimation model (CiP-CAFE).

[10] The input parameters required for the model include the regional annual production volumes of technical CPs, international trade of CPs, distribution of CPs in end-use applications, properties of CP-containing products or articles (e.g., instantaneous use in products vs the service life of articles), physicochemical properties of CPs, as well as emission and waste factors. With these input parameters, CiP-CAFE simulates the accumulation, transport, and emissions of CPs in different global regions through the different lifecycle processes.

23. Ongoing production of MCCPs has been reported (through Annex E and Annex F submissions and in the literature) in China, India, Japan, EU, UK, USA and Qatar. Production of CPs is also expected to be ongoing in other countries (e.g. Russia), however data on quantities and MCCPs specific production is lacking. An overview of production data is provided in Table 2.1.[11].

Table 2.1. Overview of CP/MCCP production volumes

Country/Region	Volume (tonnes)	Year	Reported as	Source
China	1,100,000	2014	CP	Chen et al., 2022
	900,000	2020	CP	WCC 2022 Annex E submission (based on Chinese Chlor Alkali Industry Assoc data)
	600,000	2013	MCCP	Gluge et al., 2018
India	226,400	2010	CP	Chen et al., 2022
	500,000-700,000	2018	CP	WCC 2022 Annex E submission
Japan	2,507	2020	CP	Japan Annex F submission [total of production and import]
Europe[12]	33,000	2022	MCCP	EU 2022 Annex F submission
Russian Federation	27,000	2011	MCCP	Gluge et al. (2018); ECHA 2022, based on data from WCC, 2012
USA	11,000	2021	MCCP	WCC-CPIA 2022 Annex F submission
Qatar	30,000	2021	MCCP	Qatar 2022 Annex F submission
Republic of Korea	3,737	2018	MCCP	Republic of Korea 2022 Annex F submission
UK	40,000	1991	MCCP	Gluge et al., 2018
	<10,000	2020	MCCP	WCC/CPIA (pers.comm)
Australia	1,000-10,000	2006	MCCP	NICNAS, 2020

24. The increase in global CP manufacture volumes in the period 2005-2012 is reported to have come primarily from China (Van Mourik, 2016). Based on information from Chen et al. (2022) and Li et al. (2018) there are around 100 to 150 Chinese CP producers. China is reported to have produced 0.9 Mt/year of total CPs in 2020, (WCC, 2022 Annex F submission).[13] Glüge et al. (2018) estimated that the global annual manufacture of MCCPs might be in the order of 0.6 Mt in China in 2013[14]. From a nationwide survey of producers and downstream users and measurements of concentrations in products, Chen et al. (2022) estimated that ~0.45 Mt of MCCPs were used in China in 2019, which is notably lower than indicated volumes of production, however an estimated production volume is not available for the same year.

25. The main technical CP products manufactured are CP-42, CP-52 and CP-70, of which CP-52 accounted for nearly 90% of the CP manufactured in China in 2012 (ECHA, 2022 based on WCC, 2013 data[15]). While it is noted that there is variation in the C_{10-17} congeners observed in these commercial products, attributed to the varying composition of the n-alkane feedstock used for production, typically 'MCCPs', i.e. C_{14-17} have been shown to be the predominant chain lengths observed for these products (see UNEP/POPS/POPRC.18/5/Add.1).

26. India is currently considered the second largest worldwide manufacturer of CPs (Guida et al., 2020). It is estimated that production volume of total CPs was 0.23 Mt in 2010, rising to an estimated 0.5-0.7 Mt in 2018 (WCC, 2022 Annex F submission[16]). This could indicate production volumes are close to those observed in China. However,

[11] It is noted that production data has been reports by Parties and Observes, and in the literature, both for CPs in general and MCCPs specifically. In the reporting in this risk management evaluation, a distinction is made between CPs and MCCPs for the data included where possible.
[12] Estimated aggregated tonnages of substances containing CPs with $C_{14–17}$ chain lengths and aggregated tonnages of CPs with C14–17 chain lengths congeners, manufactured and used in the EEA (excludes the UK).

[13] Based on data from Chinese Chlor Alkali Industry Association
[14] Based on mean percentage (57%; in range 29 – 67%) of MCCP in CP-52 and estimation of annual manufacture of CP in China (1 050 000 tonnes in 2013)
[15] Based on data from Chinese Chlor Alkali Industry Association (CCPIA)
[16] Estimate based on data provided at the 2018 CP conference (unpublished).

there is no specific information available on MCCPs production volumes (Chen et al., 2022). In the USA, it is noted that production, import and use of chloroalkanes is generally declining and the USA now represents <1% of the global chloroalkane market (WCC, 2022 Annex F submission). MCCPs were reportedly the most common commercial form of chloroalkane in the USA from 2014 to 2021, comprising 60-69% of the total chloroalkane market. It was reported that production of SCCP and MCCP (C_9 to C_{17}) in the USA was ~45 000 tonnes in 2007 (US EPA, 2009). The USA has reportedly decreased MCCP production to just under 11,000 tonnes in 2021, with over 60% of the produced MCCPs being used within the USA as well (WCC-CPIA, 2022 Annex F submission). It is indicated that 550 tonnes of MCCPs were supplied to Canada in 2017, a decline of 28% since 2013 (Annex E information, Canada).

27. In the EU, there are currently 11 active registrants of MCCPs[17] under EU REACH, with the registration tonnage in the 10,000-100,000-tonnage band (ECHA, 2022). Within the European Economic Area (EEA) it is estimated that 33,000 tonnes of MCCPs are produced each year with a further 25,000 tonnes imported (EU 2022 Annex F submission). There is reportedly ongoing manufacture of MCCPs in the UK with one known manufacturer identified. Glüge et al. (2018) estimated that UK production was around 40,000 tonnes in 1991, while more recent data from the CP industry suggests that by 2020 the production in the UK had declined to <10,000 tonnes.

28. Russia is indicated as a producer of CPs (WCC, 2022 Annex F submission) however no recent data on quantities is available. It is reported that MCCPs manufacture in Russia increased from 21,000 to 27,000 tonnes from 2007 to 2011 (ECHA 2022, based on data from WCC, 2012). CPs have been produced in Egypt and South Africa, but the information on production volumes and specific MCCPs production is limited (Chen et al., 2022).

29. According to the Japan 2022 Annex F submission, the combined total production and import volumes in Japan increased from 306 tonnes in 2017 to 2,507 tonnes in 2020. According to their respective Annex F (2022) submissions, Argentina, Guatemala, Oman, and Saudi Arabia do not produce MCCPs. Saudi Arabia reports the import of 30 tonnes of MCCPs per year (Argentina; Guatemala; Oman; Saudi Arabia, Annex F submission).

30. A geographic shift in MCCPs production has been observed in recent years and reported in the literature (see ECHA, 2022; Chen et al., 2022). Manufacture of CPs has decreased in Europe and North America, but has increased significantly in Asia (e.g. India, China) (ECHA, 2022). It is indicated by the CP industry (CPIA pers. comm, 2022) that today the global CP industry is dominated by China and India, with 90-95% of the global production located in these countries, reflecting their growth and industrialisation in recent decades.

Uses

31. Due to their physico-chemical properties (varying carbon chain lengths and chlorine content, high chemical stability, flame resistance, viscosity, low vapour pressure, strength at low temperatures) and low costs for production, CPs are used for a wide range of applications (ECHA, 2022). EU (2022, Annex F submission[18]) provide an overview of the uses and technical functions of MCCPs (see Table 2.2).

32. As discussed in the risk profile[19] the main uses of MCCPs have been identified as: a secondary plasticiser in PVC, adhesives, sealants, paints and coatings; a flame retardant and viscosity modifier and adhesion promoter in PVC rubber compounds and other polymers, adhesives, sealants, paints and coatings, and textiles; an extreme pressure lubricant and anti-adhesive for metal working fluids; a waterproofing agent for paints, coatings and textiles; a carrier solvent for colour formers in paper manufacture; fat liquors for leather processing; and carbonless copy paper.

33. The main uses of MCCPs globally are as secondary plasticisers in polyvinyl chloride (PVC), as extreme pressure additives in metal working fluids (MWF) and as additives to paints, adhesives, sealants, rubbers and other polymeric materials (Glüge et al., 2018).

Table 2.2. Overview of main uses for MCCPs in Europe (EU, 2022, Annex F submission)[20]

[17] Based on Alkanes, C_{14-17}, chloro (CAS 85535-85-9). A total of six substances that may contain CPs with C14–17 chain lengths are registered under REACH by 46 active registrants; 33 of the registrants are manufacturers or manufacturers/ importers, three are only importers, and 10 are only representatives (appointed by a mutual agreement with a manufacturer, formulator or article producer, established outside the EEA) (EU, 2022 Annex F submission)).

[18] Based on information collated from registration data published on ECHA Dissemination website; Annex XV dossier for SVHC identification (ECHA, 2021), the UK RMOA (Environment Agency, 2019), the German RMOA (BAuA, 2020), the RoHS Annex II Dossier for EC 287-477-0 (EU Commission, 2020; KEMI 2018) and BfR (2022) product database, SCIP data.

[19] UNEP/POPS/POPRC.18/5/Add.1

[20] As presented in ECHA(2022), based on the call for evidence conducted by ECHA in 2020, the MCCP REACH Consortium undertook a survey to collect information on the tonnage of MCCP (Alkanes, C14-17, chloro) used in

Use name	End products applications and examples of applications	Main technical functions	Proportion of the use by MCCP supply volume[21]	Average concentration in end products (%)[22]
PVC	Soft PVC material (wire and cable, hose and sealant strip); Electric and electronic equipment; enclosures and housings; cables; sheaths; caps; insulation sheets of components and electric and electronic equipment used in the construction sector; conveyor belts; PVC calendering film (packaging film, soft door curtain and artificial leather)	Flame retardant Secondary plasticizer	~ 26 %	5-18 %
Use in adhesives and sealants	Polyurethane (PU) and polysulfide-based sealants; PU ("one-component") foams used in the construction sector; insulating glass polysulfide sealants for use on windows; adhesives used in automotive industry; tapes used in construction sector and aerospace applications; rigid polyurethane foams (RPUFs); polyurethane plastic track; polyurethane joint filler	Plasticiser Flame-retardant Viscosity Modifier Insulant Non-volatile filler Adhesion promoter	~ 60 %	10-30 %
Use in Rubber	General rubber goods that require flame retardancy properties, notably in rubber conveyor belts and rubber tubes used in mining and underground activities; O-rings in automotive applications (e.g. oil tanks); sleeves for cooling systems; rubber grommet in electrical components; rubber and plastic insulation material.	Plasticiser Flame retardant Waterproofing Agent	~ 5 %	10-15 % (rubber conveyer belts) 3-10 % (O-rings, sleeve for cooling systems and rubber grommet)
Use in metal working fluids (MWF)	Substances containing CPs with $C_{14–17}$ chain lengths are added to certain types of metal working fluids (e.g. neat oils) which are used in the processing of certain metals under extreme conditions. Metal parts resulting from metalworking operations are used in the manufacture of components for automotive, aerospace and electronic applications, as well as the production of high specification components for nuclear and military applications, deep sea oil and gas extraction and heat exchangers in	Extreme Pressure (EP) Additive	~ 5 %	5 % (light machining) up to 70 % (heavy drawing process)

various applications in 2019 in the EU (excluding the UK).

[21] Based on EU data

[22] The concentration data in the EU Annex F submission draws on evidence from the call for evidence during the REACH restriction process, BfR (2022), SCIP and ECHA dissemination website, and the market survey conducted by ECHA

	conventional and renewable power generation			
Use in paints and coatings	Protective coatings and marine coatings that provide water and chemical resistance to the treated surfaces; anti-fouling paints and coating (as co-formulant in biocidal product); intumescent coatings, used to protect steel substrates of constructions exposed to fire and which work by increasing in volume when exposed to heat; flame retardant paints (indicated to be mostly obsolete).	Flame retardant. Plasticiser Viscosity modifier Adhesion Promoter	~ 1 %	4-15 %
Other uses in mixtures (lubricants)	Lubricants	Lubricants	~ 2 %	n/a

34. Metal parts resulting from metalworking operations which rely on the use MWFs containing CPs with $C_{14–17}$ chain lengths are used in the manufacture of components for automotive, aerospace and electronic applications. They are also used to produce high specification components for nuclear and military applications, deep sea oil and gas extraction and heat exchangers in conventional and renewable power generation (EU, Annex F submission, 2022).

35. In PVC applications, CPs are commonly favoured, particularly in combination with epoxides (Schiller, 2015). Due to their chlorine content CPs improve fire retardancy but their ability to form hydrochloric acid when heated, reduces PVC thermostability. However as additional secondary plasticisers, the ability of epoxides to neutralise hydrochloric acid results in a better thermostability than the use of chlorinated paraffin without epoxy plasticisers (Schiller, 2015). Input from Plastic Recyclers Europe (PRE, pers. comm, 2021) indicates that when MCCPs are used in cable formulations, the %w/w concentration used in individual cables can be around 7-10%. This can vary depending on the type of cable, e.g. oil- and Petrol-Resistant Cables (7%); flame-retardant cables (8.5%); low-temperature cables[23] (10%).

36. CPs are often used as additives (e.g for flame retardants, softeners, waterproofing, fatliquoring, anti-incrusting) in consumer goods, including a range of polymeric products associated with frequent contact or indoor release (Guida et al., 2020). Recent studies have reported measured concentrations of CP mixtures including those containing MCCPs in common consumer goods with some concentration data reported (Guida et al., 2020; Brandsma et al., 2019, 2021; McGrath et al. 2021; Wang et al., 2018, 2019; Xu et al., 2019). For example, MCCPs have been measured in food packaging[24] (up to 10 mg kg^{-1}), rubber track material, e.g. for athletics surfaces (up to 160,000 mg kg^{-1}); adhesives (up to 202,000 mg kg^{-1}); rubber granulate (up to 54 mg kg^{-1}); playground tiles (up to 51 mg kg^{-1}) and car tyres (up to 60 mg kg^{-1}). MCCPs were generally measured in slightly higher concentrations than SCCPs (Xu et al., 2019).

37. Furthermore, Wang et al. (2018, 2019) measured the CP content of several consumer goods with direct contact to human food (e.g. disposable tableware, bottles, beverage bottles, nursing bottles, lunch boxes) and also performed leaching experiments, and reported MCCP concentrations ranging from 0.02 to 36 mg kg^{-1}. Recent research in waste goods has indicated the presence of MCCPs in furniture textiles, end-of-life vehicles, waste electrical and electronic equipment (WEEE), PVC cabling and several other PVC products (for example, up to 1,700 mg/kg MCCP in rejects from the recycling of fridges, and 30 - 210 mg/kg in ELV shred fractions) (NEA, 2021).

38. Japan (2022, Annex F submission) reported that major uses are additives for metal working oils used in the manufacturing processes of parts for aircraft, semi-conductor manufacturing equipment and medical equipment. Qatar (2022, Annex F submission) reported that CPs are being used for the manufacturing of joint sealants and as filler material in packaging. Canada (2022, Annex F submission) reported that MCCPs were used mainly in the formulation of metal working fluids, followed by use in PVC plastics, rubber and elastomers, paints and coatings, and adhesives and sealants.

39. Argentina (2022, Annex F submission) indicates that CPs are used to achieve fire retardant properties in painting products by at least two companies and in PVC products by at least three companies. Guatemala (2022, Annex F submission) has reported CPs use in multiple applications, such as plasticisers in paints, flame retardants in rubbers and polymers, secondary plasticiser of flexible polyvinyl chloride or PVC, additives in high pressure

[23] i.e. cables operating in low (down to –50°C) conditions

[24] Including packaging for chips, cookies, dried fruit, and pies, “mainly made with biaxially oriented polypropylene (BOPP) and vacuum metalised PET (VMPET).

lubricants for metal cutting, leather treatment and textile finishes, and additives for sealants and waterproofing. In Saudi Arabia (2022, Annex F submission) MCCPs are reportedly used in the manufacture of high-density production catalyst from mixtures of 10%.

40. Chen et al. (2022) gathered data from a literature review to calculate quantities of MCCPs manufactured in different geographies (from 1930 onwards), trade, stockpiles, and use of MCCPs in manufacturing activities around the globe. This demonstrated that some countries are net exporters and other are net importers. Importantly it also illustrated that use of MCCPs in manufacturing processes varies geographically. Based on a modelling approach (discussed above), Chen et al (2022) identified substantial differences in the relative proportion of MCCP use in different manufacturing applications. (see Table 2.3). Based on detected concentrations in commercial products sold in Chinese markets, in 2019, close to 0.45 Mt of MCCPs were used in China (Chen et al., 2021).

Table 2.3 Regional use distribution of MCCPs among five key end-use applications (Chen et al., 2022)

Region	PVC	Metal-working fluids	Rubber	Adhesives & sealants	Paints & varnishes
China[25]	75%	1%	18%	6%	0%
Australia, S Korea & Japan[26]	30%	50%	8%	6%	6%
Bangladesh, India & Jordan[27]	53%	27%	11%	5%	4%
Russia[28]	53%	27%	11%	5%	4%
EU[29]	85%	6%	4%	3%	2%
Canada & USA[30]	21%	52%	12%	6%	9%
South America & Africa[31]	53%	27%	11%	5%	4%

41. It is estimated that the majority of MCCPs use in China and Europe is in PVC, while in North America and Japan, the majority of MCCPs use is for metal working fluids (Chen et al., 2022). Information provided by the Chinese CP industry suggests the current distribution of uses for CPs in China is as follows: polyurethane grout (25%); cable material particles (19%); soft curtain (10%); mine conveyor belt (9%); PVC soft tube (8%); rubber insultation (7%); rubber track (6%); carpet (3%); and others (13%). This direct indication from the industry suggests a discrepancy with the Chen et al. (2022) estimate with a higher demand from use in polyurethane adhesives, a relatively lower proportion of use in PVC than suggested by Chen et al. (2022); however both sources indicate a relatively low proportion of use in metal working fluids in China.

42. It is also noted there is a discrepancy between the estimates for the proportion of MCCPs use across different applications, between the EU (2022, Annex F submission) estimate and the modelled estimates of Chen et al. (2022) for uses in Europe. It is indicated in ECHA (2022) that use in adhesive and sealants is the current dominant use in Europe, while Chen et al. (2022) suggests the dominant use is in PVC. The data used to derive the Chen et al. (2022) estimates were obtained from Gluge et al. (2018). Considering the EU (2022, Annex F submission) data was based on information gathered directly from registrant producers and users, it can be considered a more reliable estimate. It should also be noted that, a past estimated use of MCCPs in different uses in Europe (EC, 2005; Entec, 2008 as cited in Danish EPA (2014)) indicated that up to 1996, the dominant use category was use in PVC (83% of total). Since then, a decline in use for MCCPs in PVC was reported. This has been attributed, in part, to MCCPs being less compatible with primary plasticisers such as diisononyl phthalate (DINP). The decrease in the use of MCCP may likely be a consequence of the gradual substitution of diethylhexyl phthalate (DEHP) by DINP and other higher phthalate plasticisers (ECHA, 2022).

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[25] Derived from Chen et al. (2021)

[26] Derived from Mej (2018)

[27] Due to the lack of available information, the averages of use distributions of other regions used as the use distribution of MCCPs and LCCPs in these regions.

[28] See footnote 28

[29] Derived from Glüge et al. (2018)

[30] Derived from US EPA (1993)

[31] See footnote 28

43. Similarly, The CP industry (CPIA pers. comm, 2023) indicate that there is a discrepancy between the data on MCCPs use in the USA from the Chen et al., (2022) modelling and data collected by the industry directly. It is suggested based on industry data (WCC pers comm, 2023) that polymer and rubber account for 55-60% and metalworking fluids for 35-40% use in the USA.

44. Due to the volumes of MCCPs that are expected to exist in ‘in use’ stocks (i.e. the volume of MCCPs Rob contained in products currently in use) (see Section 2.1), it is important to consider the historical patterns of use, globally and nationally. According to the model estimates from Chen et al. (2022), globally, the majority of the historically manufactured CPs has been used in PVC products, accounting for 40 to 50% from 1930 to 1999, and 50 to 66% from 2000 to 2020. Metal-working fluids were estimated to account for 30 to 34% of total CPs used from 1930 to 1990 and for 12 to 29% from 1990 to 2020. Other main uses globally include rubber and other plastics (10 to 14%), adhesives and sealants (5 to 6%), and paint and varnishes (3 to 10%) (Chen et al., 2022). From 1930 to 2020 MCCPs accounted for 57 to 74% of global in-use stock of CPs. Despite the expected decrease in annual rate of production of CPs globally since 2014, the total volume of ‘in use stock’ of MCCPs globally has continued to increase, reaching 13 Mt in 2020 (Chen et al., 2022).

Trade

45. Based on the results of the Chen et al. (2022) modelling and analysis conducted on emission of CPs for different global regions, the authors suggested that differences between volumes of production and use of CPs between global regions indicates the occurrence of net transboundary trade of CP commercial products. For example China and India are net exporters of CPs (as well as CP-containing products) to other regions, while Japan, South America, and Africa are net importers CPs from other regions. However, limited quantitative data on the volumes of trade for specific commercial products or mixtures of CPs or MCCPs are available.

46. It has been suggested by the CP industry (WCC, pers. comm, 2022) that the global trade in specific products that could be expected to contain MCCPs (e.g. based on the above discussion on uses) could represent an important ongoing and future route of MCCPs entering the market (and subsequently the environment) for certain regions (e.g. Europe, USA) where national/regional level restriction is being considered.

47. For example, statistical data from the UN Comtrade database and World Bank’s World Integrated Trade Solution (WITS) database are available on the import and export quantities of specific products. This includes both the broad product categories, known to contain MCCPs (PVC, MWFs, rubber, adhesives and sealants) and specific product types (including electronic equipment and cables, and rubber conveyor belts) that are expected to contain MCCPs, see Table 2.4 below. This trade information indicates that considerable volumes of these products (and by extension the MCCPs contained in them) are traded globally and this can be expected to lead to release of MCCPs related to use of these products in global regions that do not produce MCCPs or these products in substantial volumes.

48. Other studies have used the UN Comtrade Database for the period 1996 to 2018 to compile data on importation of MCCPs and products which may contain MCCPs. For example for Nigeria, Babayemi et al. (2022) used the Harmonised System (HS) codes relevant to MCCPs usually include plasticisers and other product categories. These amounted to 230,000 and 518,000 tonnes of product respectively but without specific information on the type of plasticiser. According to Kenya (pers.comm, 2023), about 39% of PVC and rubber imports of approx. 2.7 Mt and 3.5 Mt respectively are estimated to contain plasticisers. Based on the MCCPs impact factors from the literature for China, estimates were derives for the amount of imported MCCPs in PVC products (~25,600 tonnes), rubber products (~32,300 tonnes), and PUR foam (2,000 tonnes).

Table 2.4 Summary of main importers/exporters of selected products likely to contain MCCPs (2021 data)[32]

Product	Year	Total volume traded globally (tonnes)	Main exporters	Main importers	Source
PVC	2021	2,236,944	China (9%) Germany (5%) Italy (5%)	Mexico (5%) China (3%) Poland (3%)	UN Comtrade database
Rubber	2021	21,109,185	Rep. Korea (10%) Thailand (7%) Vietnam (6%)	China (17%) Malaysia (5%) India (3%)	UN Comtrade database
Metal Working Fluids	2021	3,642,876	Germany (6%) France (5%) USA (4%)	China (8%) Germany (3%) France (2%)	UN Comtrade database
Adhesives and sealants	2021	947,379	China (17%) Germany (4%) USA (4%)	Belgium (5%) USA(3%) Russia(3%)	UN Comtrade database
Insulated electric conductors; co-axial cable and other co-axial electric conductors	2021	549,585	China (39%) EU (6%) USA (4%)	USA (4%) EU (2%)	WITS database
Insulated electric conductors; optical fibre cables	2021	854,525	China (47%) Mexico (10%) EU (9%) USA (5%)	Mexico (11%) EU (9%) USA (8%)	WITS database
Rubber; vulcanised, conveyor or transmission belts	2021	82,625	China (31%) USA (19%) EU (7%)	USA (8%) EU (5%) Russian Federation (5%)	WITS database

Emissions

49. [It should be noted that this section on emissions will be updated in the subsequent draft to include further analysis. The work by Chen et al, 2022, provides a key paper and a valuable effort to globally quantify MCCP emissions, but this needs to be built upon with improved information and updated emission estimation techniques. Other key references include the work by Gluege et al (2018), the EU REACH restriction (2021) and risk assessments in the US as well as updated OECD emission scenario documents for the sectors in which MCCPs are used. With a few exceptions, data on emissions, and in particular emission estimates at national/international level are very scarce,

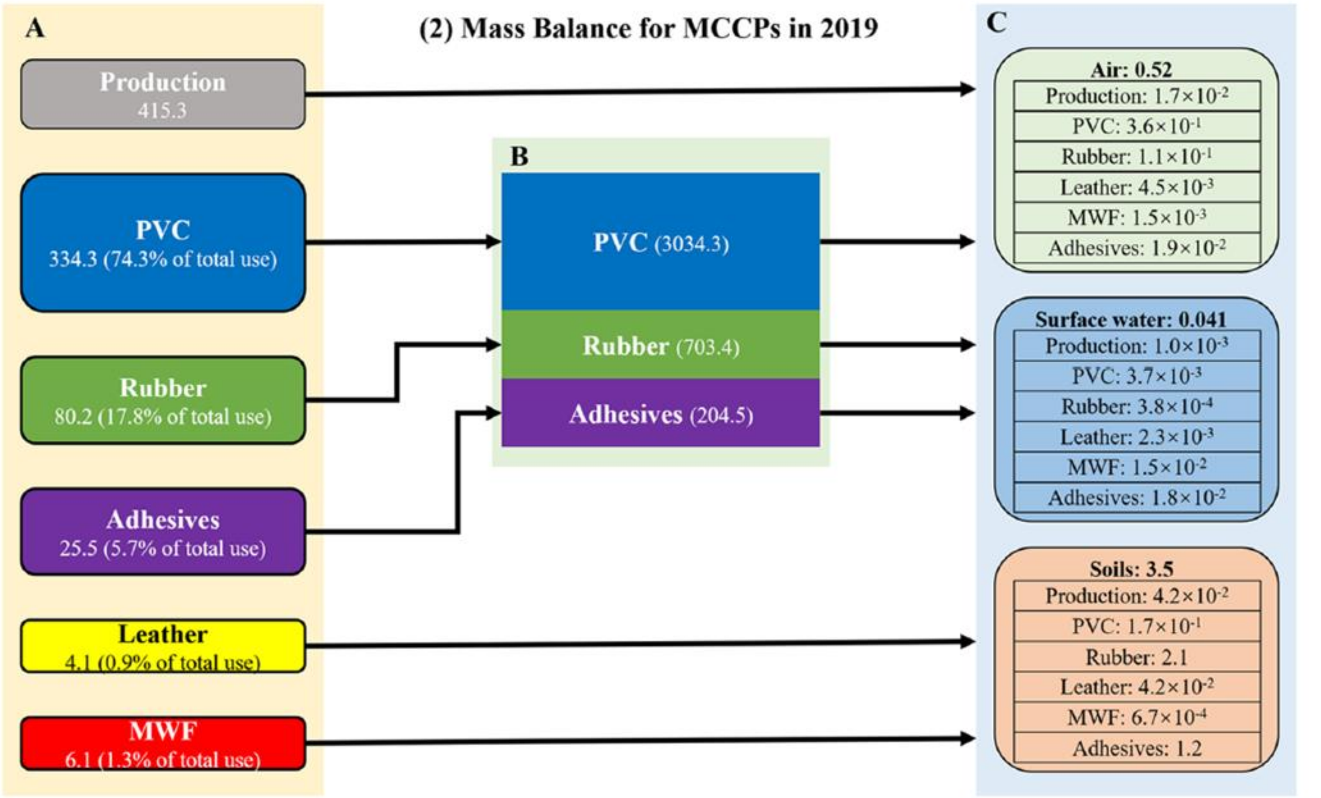
[32] Based on % of total global imports and exports (by tonnage); data from the World Integrated Trade Solution (WITS); https://wits.worldbank.org/Default.aspx?lang=en; and UN Comtrade database : https://comtradeplus.un.org/

representing a significant area of uncertainty. The drafters propose to develop generic emission estimates (based e.g. on OECD ESD estimates and taking into account EMEP guidance) for areas of the globe without specific emission estimates, and to supplement those with more specific data where regional estimates are available (e.g. the EU and USA). This is not intended to supersede or replace existing references but to provide additional context and insight.]

50. MCCPs can potentially be released to the environment throughout their lifecycle from production, use in industrial processes, during the service life of products (both consumer and industrial application), and disposal of waste and/or recycling of materials containing MCCPs (Guida et al., 2020). Based on the modelling conducted by Chen et al. (2022), it is estimated that by 2020, 5.2 Mt of historically produced CPs were released into the environment globally with the annual emission rate (of total CP) increasing to approximately 193,000 tonnes in 2020 (~20-25% of what is produced and used annually). The proportion of the annual emission rates among different classes of CP is not provided, however MCCPs are estimated to account for ~ 40% of the cumulative CP emissions (~77 000 tonnes).

51. Based on their modelling, Chen et al. (2021) estimated the emissions to air, surface water and soils from the production and key end uses of MCCPs in China as shown in Figure 2.1.

Figure 2.1. Mass balance diagrams showing the volume (kt) of MCCPs from production and use to emission in 2019 in China (Chen et al., 2021)[33]



52. However, Chen et al (2022) did not consider emissions during or after the disposal stage (e.g., leaching, runoff, or volatilisation from disposal sites) due to scarcity of information. Based on the cumulative emissions, the study concludes that Soils received most (74%), followed by freshwater (16%) and air (10%). The authors further note that a dominant pathway (84% of all emissions) is via wastewater treatment works. This was attributed to the manufacture of MCCPs and use within industrial settings. Wastewater treatment works were further identified as a point of release for emissions to air, surface water, and land through application of biosolids.

[33] (A) Production and sector-specific use of MCCPs in 2019. (B) Sector-specific in-use products in 2019. (C) Emissions of MCCPs during their production and use. Volumes of production, use and emissions presented in units of kilotonnes (kt). Emission factors used to derive emission volumes were derived from the available literature (see Table S17 in Chen et al., 2021) supplementary material.).

53. The EU (ECHA, 2022) estimates that in Europe, the majority of MCCPs emissions to the environment are released to air, followed by soil and surface water (EU Annex F submission 2022). The estimated releases to the environment in the EU are detailed based on environmental compartment and by use in Tables 2.4 and 2.5 respectively.

Table 2.4 Estimated total releases of MCCPs in the EU by environmental compartment (EU, 2022 Annex F submission)[34]

Emission compartment	Total release per year (tonnes)[35] ; % of total
Total releases to surface water	260-430 (5-8%)
Total releases to air	3900-4000 (75-77%)
Total releases to soil	1100-1900 (21-37%)
Total releases (all environmental compartments)	5200-6300

Table 2.5 Estimated total releases of MCCPs in the EU by use[36] (EU, 2022 Annex F submission)

Use	Total release per year (tonnes)[37]	Proportion of total (%)
PVC	440-1100	(9-18%)
Adhesives/Sealants	4300	(69-82%)
Rubber	230	(4%)
Metalworking fluids	34-250	(1-4%)
Paints/coatings	85-160	(2-3%)
Leather	3-24	(0.1-0.4%)
Other	140	(2-3%)
TOTAL	5,200-6,300	

54. Emissions of MCCPs from production plants are expected to occur mainly through volatilisation and dust drift, but since the chlorine gas and hydrochloric acid are recovered and the volatility of CPs is relatively low, this loss is likely to be low (BiPRO, 2007, cited in ECHA, 2022).

55. A potentially important source of environmental pollution resulting from industrial activity is the use of CPs in metal working fluids and lubricants. For example, CPs from metalworking/metal cutting fluids may be released into aquatic environments from drum disposal, carry-off and spent bath use, as well as the cleaning of metallurgical facilities (BiPRO, 2007, cited in ECHA, 2022). While Table 2.5 indicates use of MWFs represents a relatively minor proportion of emissions in Europe (4%), this could be attributed to the relatively lower level of use in Europe (5-6%). In other global regions (e.g. North America, Japan) this could represent a more significant source of emissions as the proportion to total use is higher (~40% in USA ; ~50% in Japan).

56. There is, however, the potential for metal working fluids to be recovered and treated. For example, the CP industry notes (WCC, pers. comm, 2022) that recent informal communications with several large metalworking

[34] Releases of CPs with C14–17 chain lengths calculated by ECHA during the dossier preparation of the restriction proposal under REACH are not identical to those calculated previously for the EU (Environment Agency, 2019, ECHA, 2022), mainly due to differences in input tonnage, uses considered and tonnage split per use.

[35] The lower bound corresponds to the releases estimated with the lowest release factors and lowest fraction of substances going to waste. On the contrary, the highest bound is calculated using the highest release factors and highest fraction of substances going to waste. Details of the approach to estimate the releases and assumptions, as well as detailed estimates, are available in ECHA (2022; Appendix B).

[36] EU 2022 Annex F submission. Table 5.

[37] Minimum based on lower bound estimate; Maximum based on upper bound estimate

operations in USA indicate that these facilities generally do not discharge waste oils/fluids to surface water but rather use regulated hazardous waste handlers to dispose of these wastes. Of the ~4350 tonnes of MCCPs and LCCPs used in metal working fluid applications in the USA in 2014, a survey by the WCC and the CPIA indicated that the total release to water was around 0.3 tonnes (WCC-CPIA 2022 Annex F). further information on how this figure was calculated was not provided within the Annex F response, other than to highlight that onsite treatment primarily focus on separation of oil and water, with chlorinated paraffins retained in the oily fraction. In the EU waste oils are regulated under the waste framework directive[38]. This states that waste oils must be collected and managed separately from other wastes (i.e., they cannot be put to sewer); and furthermore, where technically and economically feasible different grades of waste oil should not be mixed together to form a batch. The EU waste framework directive also requires operators to consider the hazardous nature of wastes in terms of consignment and final management options (including irreversible destruction). Standard practise in other countries is not known, but information on this would be welcomed by the drafters of this RME.

57. Overall, it is estimated that in Europe (EU, 2022, Annex F submission) releases from industrial settings (manufacture, formulation and industrial uses) account for 5-8 % of the total releases; releases from wide dispersive uses (professional uses, consumer uses and service life) account for 10-21 % of the total releases; and that the contribution of the waste stage is the highest, corresponding to 71-84 % of the total releases to the environment. It is noted that, for MWF, the emissions at waste stage were estimated to constitute 0.2-1.4% of emissions from this use. The releases from waste are due to ultimate disposal of articles and materials containing MCCPs as waste, and the high release factor during shredding of waste, especially waste from adhesives/sealants (e.g. in construction waste), which is highlighted by the EU (2022, Annex F submission).

58. MCCPs can leach from products during their service life or when disposed of to landfill. For example, Brandsma et al., 2021 investigated the release of CPs from new and used spray polyurethane foams (SPFs), noting the end-of-life phase is particularly significant as these materials are challenging to recycle. Chen et al (2022) estimated that production of CPs and industrial processing of CP-containing products account for approximately 4% of cumulative global emissions and in-use stock accounts for approximately 9% . Wastewater treatment is identified by Chen et al. (2022) as the dominant emission pathway for CPs (accounting for ∼84% of the cumulative global emissions) assuming direct release to wastewater of expired/waste metal working fluid MWF, however, as noted in the above sections, there is considerable uncertainty around these estimates, as well as geographical differences between waste handling between regions.

Even with a restriction/prohibition of production and use of MCCPs, and better controls on potential emissions during production, emissions to the environment are likely to continue due to the emission of MCCPs from products that are currently in use, as well as newly manufactured products. For example, paints, adhesives, and sealants used in construction, as well as PVC in cables and other applications are likely to remain in use for many years.

2.2 Identification of possible control measures

Overview

59. The objective of the Stockholm Convention (Article 1) is to protect human health and the environment from POPs. This may be achieved by listing MCCPs in:

(a) Annex A to eliminate releases from intentional production and use (specific exemptions allowed); or,

(b) Annex B to reduce releases from intentional production and use (specific exemptions and acceptable purposes allowed); and/ or

(c) Annex C to reduce or eliminate releases from unintentional production.

60. Control measures that result from a listing to the Convention include actions that eliminate or restrict intentional production and use of the substance as well as import and export, through listing under Annex A or B (Article 3). These control measures may allow for time-limited or on-going production or use for specific applications. Measures may also include actions to minimise and, where feasible, eliminate unintentional production through listing under Annex C (Article 5).

61. Upon listing under the Convention, Parties are required to take appropriate actions to manage stockpiles and wastes (Article 6). Being mindful of the precautionary approach referred to in Article 1 of the Convention, the aim of any risk management strategy for MCCPs should be, to the extent possible, to reduce and eliminate emissions and releases of MCCPs. This risk management evaluation considers socio-economic information submitted by parties and observers to enable a decision to be made by the Conference of the Parties regarding possible control measures.

[38] Directive 2008/98/EC on waste

Control measures for releases from intentional production and use

62. As outlined above (Section 2.1), quantitative estimates for the levels of ongoing production and use of CPs, including MCCPs specifically, have been made at national, regional (e.g., EU (ECHA, 2022) and global levels (Chen et al., 2022). It has been indicated that the global production volumes of MCCPs, as well as the measured concentrations in the environment are currently much higher than those of SCCPs (which are now listed as POPs under Annex A of the Convention, restricting their manufacture and use with a limited number of specific exemptions[39]) – see risk profile (UNEP/POPS/POPRC.18/11/ Add.3). This can be attributed to a large extent to MCCPs and LCCPs replacing SCCPs in their applications in the short- or medium-term following the listing of SCCPs under the Convention (see risk profile).

63. As discussed above (Section 2.1), modelling conducted by Chen et al. (2022) indicates that global production and use of MCCPs (and CPs generally) increased steadily from 1930 to 2000, followed by a substantial increase between 2000 and 2010, driven largely by a rapid increase in Asia (China and India in particular), after which production and use plateaued, followed by a slight decline in the past 10 years (Chen et al., 2022). The fact that this trend in the modelled production data is observed for CPs as a whole could potentially indicate that non-CP alternatives are becoming increasingly available, and that substitution is actively taking place in most uses. With the above considerations, listing MCCPs under either Annex A or B could therefore be considered an appropriate control measure to prohibit or limit the release from this intentional production and use.

64. The listing of MCCPs in Annex A, without any specific exemptions, could be considered as a control measure to eliminate the production and the remaining uses at the global scale and to prevent the re-introduction of other uses. This listing would subject MCCPs to the provisions of Article 3 of the Convention, requiring parties to take the legal and administrative measures necessary to eliminate production and use and to only import and export MCCPs in accordance with the Convention. Listing under Annex A would also allow for the registration of specific exemptions for the production or use of MCCPs, in accordance with that Annex and with Article 4.

65. Listing under Annex B would allow for the registration of acceptable purposes for the production and use of MCCPs, in accordance with that Annex, as well as the registration of specific exemptions for the production and use of MCCPs, in accordance with Annex A and with Article 4. The import and export of chemicals listed in Annex B can take place under specific restrictive conditions, as set out in paragraph 2 of Article 3.

66. The efficacy and efficiency of control measures targeting intentional production and use of MCCPs (i.e. listing under Annex A, with or without specific exemptions, or listing under Annex B) and the potential inclusion of specific exemptions/acceptable purposes in the context of the Convention, will need to consider the availability and technical and economic feasibility of alternatives across different uses, as well as the implications for monitoring and enforceability. This is further considered, in relation to the information submitted by Parties and Observers and additional data gathered by the drafter in the subsequent sections of this dossier.

Control measures for releases from unintentional production

67. Article 5 of the Convention covers measures to reduce or eliminate releases from unintentional production, requiring Parties to take measures to reduce the total releases derived from anthropogenic sources of each of the chemicals listed in Annex C, with the goal of their continuing minimization and, where feasible, ultimate elimination. The ‘scope’ of MCCPs covered by this risk management evaluation is based on specific carbon chain length and degree of chlorination, and specifically includes *“any CP product that has constituents with 14 to 17 carbon atoms ($C_{14–17}$) and a chlorination level at or exceeding 45% Cl wt”*. In this context, and in the context of the Convention text, it is important to differentiate here between what is considered *‘unintentional production’* and what would be strictly considered *‘unintended constituents’* within other commercial CP products.

68. There is no evidence that MCCPs are unintentionally formed by thermal processes such as incineration because they are not thermally stable, and instead are expected to be degraded. Therefore, control measures for the unintentional formation of MCCPs from thermal process (i.e. listing under Annex C) are not expected to be required.

69. As discussed extensively in the risk profile[40] and in the ECHA (2022) restriction proposal, as a result of the complex composition of CPs produced, MCCPs are considered a ‘substance of unknown or variable composition’ (UVCBs). It is noted that commercially supplied CP products consist of different carbon chain lengths (reflecting the carbon chain length distribution in the parent hydrocarbon feedstocks used), and have different degrees of chlorination (ECHA, 2022).

[39] COP decision: SC-8/11

[40] UNEP/POPS/POPRC.18/5/Add.1

70. Commercially available MCCPs products will generally include multiple carbon chain lengths with the presence of significant amounts of at least C_{14} chloroalkanes (Environment Agency, 2019). Furthermore, as demonstrated by chemical analyses of commercial CPs in the literature (e.g. see Bogdal et al., 2015; Yuan et al., 2020; Chen et al., 2021) the distribution of the congener groups per carbon number can include multiple chlorine contents (ECHA, 2022). A study by Yuan et al. (2020) calculated that the number of possible isomers for $C_{14}Cl_{1-10}$ and $C_{15}Cl_{1-7}$ CPs exceeds 41,000.

71. Information presented by Environment Agency (2019) indicates that chlorinated C_{14} carbon chain lengths are the dominant congener group in commercially supplied MCCP-containing products in Europe, however, a small (<1%) proportion of 'unintentional' chlorinated alkanes with carbon chain lengths $<C_{14}$ can be present in MCCP-containing products.

72. With regards to the degree of chlorination, the chlorine content of commercial products varies according to the applications they are used for but is generally within the range 40% to 63% by weight. In Europe, it is indicated that the majority of products have a chlorine content between 45% and 52% by weight (ECHA, 2022). The CP industry has indicated (WCC/CPIA Pers. Comm, 2022) that globally ~95% of all commercial MCCPs products will be above the 45% threshold, and that technically achieving lower average chlorination (e.g. 30-35%) is practically very challenging. The above discussion raises two potential issues relevant to the appropriate control measures to manage the environmental releases of MCCPs, with reference to the scope of congeners covered in the current proposal and the context of the Convention text.

73. First is the potential issue of MCCPs congeners (i.e. those within the scope of this proposal) being present in commercial CP products that would not be covered by listing under the Convention must be addressed. LCCPs commercial products may contain congeners with chain lengths within the C_{14-17} range, for example it was previously reported that LCCPs can contain up to 20% C_{17} (Environment Agency, 2019; HSE, 2008; ECHA 2022). One possible control measure to address this issue would be to include controls to limit the presence of MCCPs in other chlorinated paraffin mixtures to a specified level (i.e. a % proportion of C_{14-17} and >45% Cl), as was implemented in the listing for SCCPs[41]. In practice, this would likely require manufacturers to change the starting paraffin feedstock used in order to comply with this requirement.

74. As noted in the SCCPs RME (UNEP/POPS/POPRC.12/11/Add.3), the MCCPs risk profile (UNEP/POPS/POPRC.18/11/Add.3) and by Guida et al. (2020), in the USA and EU, CPs are manufactured using paraffin feedstocks with specified carbon chain lengths. Manufacturers in the EU have indicated that distinct feedstocks are purchased to manufacture SCCPs (C_{10-13}) and MCCPs (C_{14-17}). The feedstocks and products remain separate throughout the manufacturing process and are not mixed to produce distinct commercial grades of SCCPs, MCCPs and LCCPs. According to the CP industry (WCC, pers. comm., 2022), CPs produced in Asian countries such as India and China are differentiated based on their chlorine content (or viscosity) rather than by the carbon chain lengths of their constituent congeners. Therefore, this could present a challenge in ensuing the risk from 'unintentional production' of MCCP (C_{14-17} and >45% Cl) congeners present in other commercial CP products is adequately controlled through control of initial feedstocks (see Section 2.3 for further discussion).

75. Secondly, there is the potential 'unintentional' presence of CPs with chain lengths $<C_{14}$ or $>C_{17}$ (and/or chlorination >45%) in MCCPs commercial products that will have hazardous (including potential POP) properties. It is generally accepted that up to 0.5 - 1% of the paraffins in the final product could fall outside of the specified chain length range (WCC Pers. Comm, 2022). This should be considered when considering the relative efficiency of control measures in terms of providing overall protection of human health and the environment.

76. Considering the above discussion, listing under Annex C could be considered as a potential control measure (as was initially considered for the proposed listing of SCCPs[42]) as the presence of MCCPs congeners in other CP commercial products is possible. However, it will need to be considered if this strictly constitutes *'unintentional production'* of MCCPs congeners and if this would be the most effective or appropriate means of controlling the emissions to the environment, compared for example to the consideration of controls to limit concentration of C_{14-17} chain length congeners and/or >45% chlorination congeners in 'other' CP commercial products. [the drafters will ask for clarity from the Secretariat on this].

Control measures for releases from stockpiles and wastes

77. The Convention aims to ensure that stockpiles consisting of or containing MCCPs, if listed, are managed safely and in an environmentally sound manner to adequately protect human health and the environment (Article 6). It is evident from the discussion above, that for MCCPs the aspect of waste is particularly important in this respect. Guida et al. (2020) reported that due to the relatively high historical production of CPs (in comparison with most

[41] UNEP/POPS/COP.8/14.

[42] UNEP/POPS/POPRC.12/11/Add.3

POPs currently listed under the Convention[43]), the amount of waste containing CPs and the quantity of CPs released to the environment during waste management is also expected to be high. Chen et al. (2022) reported model estimates that a total of ~18.8-24.4 million tonnes of MCCPs have been produced and used globally (from 1930-2020)[44], ~40% of which still resided in in-use products by 2020. These will be available for long-term emissions in the future. The majority will be residing in PVC products (78%), followed by rubber and other plastics (11%) and adhesives and sealants (8%). This emphasises the importance of controlling emissions of MCCPs at this stage of a product life-cycle.

78. The EU (2022, Annex F submission) indicated that the highest proportion (71-84 %) of the total releases of MCCPs to the environment in Europe are due to the ultimate disposal of articles and materials containing MCCPs as waste. The authors emphasise that it is also important to note that landfills constitute a reservoir of MCCPs that is not accounted for in these values, so total long-term release from the waste phase could potentially be higher. However, it is noted that the CP industry (WCC, pers. comm, 2023) have questioned the emission estimates in the EU Restriction dossier and the overall volume (and proportion) of emission from waste estimated[45]. Guida et al. (2020) note that, when CPs are used as plasticisers or additives in coatings, they are effectively dissolved in the polymeric material, and that the CPs will therefore leak into the environment only very slowly (IPCS, 1996) when those products are disposed of, for example in landfill. This could therefore potentially act as sources of CP to the environment for a significant period after disposal. Plastic and polymer wastes that are inappropriately disposed of might also play a role in a continued source of MCCP release to the environment. This could be a significant issue in developing countries that do not have a well-designed waste infrastructure and where environmentally sound disposal and recycling of waste is not commonplace (e.g., cable burning to reclaim metals).

79. The overall global volumes of production and use of MCCPs are indicated to have increased substantially (>50% increase) between 2010 and 2020, which has largely been driven by increased production and use in China and India (Chen et al., 2022). Therefore, the amount of MCCPs entering waste streams in future years can be expected to increase accordingly.

80. As discussed by Guida et al. (2020), the variety of different uses for MCCPs, and types of products they are incorporated into across different sectors presents a range of different challenges for the appropriate handling and disposing of waste. One of these is the separation and sorting of different materials at the end of product life. For example, some CP-containing products (e.g. textiles, rubber and consumer goods) have a relatively short service life) <10 years), so may end up in waste streams relatively quickly, but it may be difficult to separate these products from uncontaminated ones at the end-of-life, presenting a challenge for recycling and reuse. A second issue are uses where the products containing CPs (in particular products used in construction such as PVC imitation wood panel ceilings and walls, sealants, flooring and adhesives used for flooring) have a relatively long service life of up to several decades. Therefore, even if CPs are phased out in the short term, it is expected they will continue to be present in construction and demolition waste in the longer term.

81. Moreover, as discussed by Chen et al. (2022), geographical differences in use patterns results in distinct temporal trends in the magnitude of in-use stocks among regions. For example, in China, with 79% of historically produced CPs used in PVC products with a relatively long service life (~15 years), up to 67% of China's historical cumulative CP production was estimated to have resided in in-use stocks by 2020. By contrast, with 52% of historically produced CPs used in metal-working fluids, only 15% of North America's historical cumulative CP production was estimated to have remained in in-use stocks by 2020. In Western Europe, the in-use stocks peaked at ~1.2 Mt in 2000 and then declined after new use of CPs was discontinued in the 1990s. By 2020, only 8% of historical cumulative production in Europe was estimated to be still retained within in-use stocks, most of which were MCCPs (89%) as the principal use of the MCCPs is in PVC products, with relatively long service life. It should also be noted, however that the issue of control measures for stockpiles and wastes should take into account the trade of MCCP commercial products and articles containing MCCPs from regions where production is high (e.g. China, India) to other global regions where the products will reach the end of life phase and those regions will be required to handle the potentially large volumes of MCCP containing wastes.

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[43] For example, it was indicated that the volumes of other POPs listed under the Convention were as follows: PFOS: 12,200 t per year (2004) ; DDT 68,800 tonnes per year between 1971-81 and currently much lower. DecaBDE 1.100.000 -1.250.000 tonnes in total from 1970-2005.

[44] Based on the estimation that During 1930−2020, it is estimated that MCCPs accounted for 57− 74% of global in-use stocks of CPs (Chen et al., 2022).

[45] This relates to the emission factors used in estimating the air emissions during solid waste disposal of articles, primarily from the disposal of building materials that contain adhesives, sealants and PVC (Waste-life exposure scenario W1); and soil emissions from disposal of waste/articles by landfill (Waste-life exposure scenario W2).

82. The results of the Chen et al. (2022) modelling suggests that different use patterns of CPs resulted in different modes of emissions dominating in different regions. For example, regions such as North America experience relatively higher instantaneous emissions of CPs into soil and aquatic environments as a result of the relatively large use in metal working fluids, for which wastewater treatment was a key emission pathway, whereas regions such as China were characterised by higher long-term emissions to air because of the dominant use of CPs in long-lived products. This demonstrates that the appropriate control measures required to best prevent or minimise release from waste will be different in different global regions.

83. While listing MCCPs to the Convention would eliminate or reduce the MCCP content in new products, thereby reducing releases from the waste stream in the longer term, control measures could be implemented to address key waste streams where existing MCCPs may be found. Ultimately, a low POP content level would need to be established that ensures the destruction or irreversible transformation of the POP, whilst also considering the practical and economic implication of dealing with waste management.

84. Waste management activities should take into account international rules, standards, and guidelines, including those that may be developed under, or in cooperation with, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, and relevant global and regional regimes governing the management of hazardous wastes. Parties should also consider emission reduction measures and the development of guidance and use of best available techniques and best environmental practices (BAT/BEP) in the waste management phase. In addition, parties must endeavour to develop appropriate strategies for identifying sites contaminated with MCCPs, as these are potential ‘hot spots’ for environmental pollution (Guida et al., 2020). If contaminated sites are identified and remediation is undertaken, it shall be performed in an environmentally sound manner.

2.3 Efficacy and efficiency of possible control measures in meeting risk reducing goals

Intentional Production

85. As outlined in the previous section, the possible control measures for intentional production and use identified broadly break down into two options:

(i) Listing under Annex A of the Convention without specific exemptions (i.e., full prohibition); and
(ii) Listing within Annex A of the Convention with specific exemptions or under Annex B with acceptable purposes for those cases where continued use of MCCPs in those applications can be justified.

86. For (i) above, efficiency of the control measure relates to the availability of alternatives, and whether it is possible to make a smooth transition to the alternatives without loss of technical function or incurring excessive costs. For (ii), the efficacy and technical feasibility of the measure relates to how emissions and exposure can be limited as far as possible, while allowing for specific exemptions/acceptable purposes and promotion of substitution to safer alternatives as soon as possible. Based on the life cycle and uses of MCCPs control measures can be very broadly grouped into three categories:

(a) Control of emissions associated with manufacture of MCCPs (assuming continued manufacture would be needed). This could also include the compounding processes for inclusion of MCCPs into PVC and rubber where relevant.
(b) Control of emissions associated with use of mixtures within industrial settings (e.g., metal working fluids, and paints/coatings). This category is identified on the basis that concentrations used within industrial settings may be higher than professional/consumer settings, but also that the available controls and understanding of the potential issues may be much stronger (depending on the sector and/or global region of use).
(c) Control of emissions associated with mixtures/articles during use for professional/consumer applications (e.g., MCCPs intentionally left in the article/mixture such as PVC cabling, sealants, and adhesives. Emissions control is on the basis that articles (such as PVC and rubber) or mixtures (e.g., adhesives and sealants) may emit MCCPs during normal service life and represent a key pathway to the environment and exposure based on large volumes of use (compared to industrial settings, albeit at lower concentrations). This also includes consideration of control measures to address the release of MCCPs at the end of product service life, when articles enter waste streams.

Prohibition (Listing within Annex A of the Stockholm Convention without specific exemptions)

87. The efficacy of a listing in Annex A without exemptions would be likely to provide the maximum benefit to avoid human health and environmental impacts by elimination of use (and therefore emissions to the environment and associated exposure). The section on alternatives (see Section 2.4) identifies a wide set of options for substituting MCCPs, suggesting that, for the majority of uses, alternatives already exist and have been commercialised. As discussed in Section 2.1, it is also expected that the international trade in commercial MCCP products as well as products containing MCCPs (e.g. electronic equipment, PVC and rubber products) are also a significant route of

MCCPs entering the market and subsequently the environment. Therefore, listing under Annex A with no exemptions would prevent import of MCCP-containing articles into other global regions.

88. Comments from Parties and Observers (e.g. in Annex F submissions) as well as additional information from industry, has however identified a number of uses where exemptions could be justified. Respondents comment that transition to alternatives may prove challenging either due to regulatory issues (e.g. compliance with safety standards) or economic and practical issues. Key sectors highlighted include aerospace/defence, automotive, construction and medical applications. It is noted that in a number of these industries, alternatives to CPs have been investigated for many years, and while some have identified and implemented alternatives to specific applications of some uses of metalworking fluids, lubricants, adhesives, and maskants[46] (as reported in their Annex F submissions) there are some specific applications where finding viable alternatives is more challenging. This is particularly the case where CPs provide a dual function (e.g. plasticiser and flame retardancy).

89. The World Chlorine Council and the Chlorinated Paraffins Industry Association (WCC/CPIA, 2022 Annex F submission) highlighted, based on consultation with the US Department of Defence, several military and/or aerospace applications involving MCCPs, which include metal parts made with MCCP-based metal working fluids. This includes the production of fasteners (for example used in aircraft and ship assembly, maintenance, and repair). The fastener-manufacturing industry suggests that it uses MCCPs as an extreme-pressure additive in the metal working fluids used to create fasteners for aircraft and jet engines, including nuts, bolts, latch pins, and rivets that are manufactured to withstand extreme temperatures, corrosive environments, and stress encountered in flight, while having the lowest possible weight. The fastener manufacturing industry also suggests there are currently no viable alternatives to MCCPs in metal working fluids identified for tapping, deep drawing of stainless steel, or titanium grinding – processes seen by them as necessary to manufacture these parts.

90. It is also reported that CPs are used in metal working fluids for forming and fabricating metals, for example stainless steel and high strength nickel alloy used in aerospace fuel lines, brake line and hydraulic systems (WCC, 2022, Annex F submission), as well as in the automotive sector, where complex shape processing and hard-to-cut machining material (stainless steel and nickel alloy) is required. It has also been noted that, for manufacture of stainless steel wire, there are currently no available substitutes that have the efficacy of CPs. Furthermore, the Adhesives and Sealants Council (ASC) in the USA highlights that CPs impart flame-retardant properties to building and construction sealants and adhesives. It is suggested that there are "no drop-in replacement[s] for these materials" and that any replacement chemistry would have to meet specific testing requirements before being approved for use in a specific application.

91. Input from the International Coordinating Council of Aerospace Industries Associations (ICCAIA, 2002, Annex F submission) also highlights that the aerospace and defence industries continue to use MCCPs in multiple important applications[47]. It was noted that transition to alternatives for aerospace and defence may be challenging. Based on other listings under the Stockholm Convention (such as DecaBDE and PFOA), it has been highlighted that in safety critical applications such as aerospace and defence material testing and approval can have very long lead-in times (10+ years). This suggests that, while potential alternatives have been identified, it may be necessary to consider the wider requirements that need to be met (e.g. testing; standards) and the timeframe required in terms of successful transition to alternatives

92. Japan (2022, Annex F submission) and CCPIA (2023, pers. comm) highlight the use of electric and electronic equipment for 'social infrastructure'[48] (where use is more than 10 years) and many applications (motor vehicle, machining equipment etc.) as important uses for MCCPs. Japan (2022, Annex F submission) also noted that MCCPs are used in replacement parts in case of breakdowns of equipment and devices with a long service life. It was highlighted that, if spare parts of electric and electronic equipment which uses PVC, rubbers, adhesive, sealants, coatings and paints are not exempted, it would impact the repair and use of those products. Therefore, they indicate that listing under Annex A without exemptions could potentially impact the supply of these parts. JAPIA (pers. comm, 2023) indicated that a transition period of 30 years from the start of the restriction would be needed for

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[46] inert substances used to protect specific areas of the material during chemical etching

[47] Specific uses highlighted include: dry film lubricants, polyurethane foam sealants, stripping paints (at airports), tapping and cutting fluids / machine working fluids, honing oils, urethane adhesives, standards media for viscosity testing and laser labs, , mould compound, tamper proof sealant, sealants/caulk (including foam sealants) for use in testing and fire retardant sealants/caulk, elastomeric coatings / moisture barrier coatings, paints and other surface coatings (conforming), rust , fire retardant paint.

[48] Including electric and electronic equipment used for, medical practice (such as clinical, diagnostic, inspection, analysis, monitoring and others) and industrial and other types of monitoring, control, analysis and measurement equipment, in laboratories, infrastructures of transportation, lifelines, security, disaster preventions, and process control.

MWFs[49]. Japan (2022 Annex F submission) also highlighted medical applications would also have issues with material testing, approval, and implementation of alternatives requiring longer lead-in times, however specific transitions times have not been indicated.

93. For the automotive sector, the European Automobile Manufacturers' Association (ACEA, pers.comm, 2023) highlighted the following important uses in the automotive sector: powertrain and under-hood applications such as powertrains, wiring and harness under hood (engine wiring, etc.), hoses, caps, tubes, filters; fuel system applications such as fuel hoses, fuel tanks, caps and fuel tanks under body; suspension and interior applications such as trim components, acoustic material and seat belts; exterior vehicle applications such as foam pads, sealers, gaskets, fasteners, windows; pyrotechnical devices and applications affected by pyrotechnical devices such as air bag ignition cables, seat covers/fabrics (only if airbag relevant) and airbags.

94. The ACEA (pers.comm, 2023) emphasised that the key challenges for the automobile industry in developing suitable alternatives include i) material testing, to ensure that the replacement substances/materials are matching the performance requirements; and ii) component testing to ensure that the component can be manufactured to the required quality meet the specification requirements. These aspects can be particularly challenging when manufacturing spare parts, where this testing is cost prohibitive due to the relatively small production volumes. The industry see this as a risk that small volume production will be stopped and spare parts availability endangered. A transitional substitution time of 5 years is suggested by the ACEA.

95. The ECHA (2022) EU REACH restriction proposal for MCCPs details a potential need for a derogation for the use of MCCPs as extreme pressure additives for metal working fluids[50]. MCCPs are used within metal working fluids to provide cooling, lubrication, anti-friction properties (through surface modification), and flame-retardancy in either water-based emulsions or oil-based mixtures (EU Annex XV dossier). The water-based emulsions (primarily used for cooling) can contain up to 8% CP (by weight), while the oil-based mixtures (primarily used for lubrication) can be as high as 70% CP depending on the specific application, with high temperature and extreme pressure needing the greatest concentrations. The ECHA (2020) call for evidence (in advance of the EU REACH restriction) identified that, for many metal working applications, chlorine-free alternatives had been identified or were already in use. Based on the information gathered through the calls for evidence and a sector specific survey, ECHA notes that substitution of substances containing C_{14-17} chloroalkanes seems challenging in the EU for 'heavy duty' metalworking processes such as 'deep drawing', 'broaching' and 'fine blanking'[51] used on hard materials such as stainless steel and titanium. The Annex XV dossier comments that MCCPs react to form a chloride layer on the workpiece reducing friction and providing a protective layer (in this respect they are multi-functional). Alternatives have required the use of mixtures of chemicals to achieve the same functional aspects for high temperature and extreme pressure applications, which have been problematic in some cases due to staining of the metal. A derogation / 7-year transition period for metal working fluids, is currently included in the EU REACH restriction dossier (ECHA, 2022). However, ECHA recognises that the scope of this derogation needs to be narrowed down, and sufficient and substantiated information on the affected processes, respective metal working fluids and socio-economic impacts would be needed during the ongoing consultation process in the EU.

96. However, for applications where high temperature (600-1,000ºC) and extreme pressure (up to 1,400 pascals) (Osama et al., 2017, GBC, 2022) are needed (e.g., deep drawing, broaching, etc) the potential for using alternatives was more problematic. This is due in part to the multi-functionality of MCCPs with no drop-in replacement, and multiple chemicals needed which could greatly increase costs (ECHA, 2022). Environment Agency (2019) noted in their assessment that there are currently no suitable alternatives for specific activities such as metal forming processes associated with deep drawing and punching, while some alternatives can pose problems with staining, odour, etc. This could indicate that specifically for high temperature, extreme pressure applications, an exemption may be needed. The EU REACH restriction dossier (ECHA 2022) includes a transition period of 2 years after the foreseen date of entry into force (January 2024), which is believed to be sufficient for phasing out MCCPs in the remaining sectors

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[49] Development of alternative substances: 10 years; Development of alternative metalworking fluid as a base: 4 years; Formulation adjustment of metalworking fluid and commercialization: 10 years; Quality confirmation of press manufacturers, parts manufacturers, and set manufacturers: 6 years.

[50] ECHA is proposing to try to narrow down the scope of this possible derogation during the Annex XV consultation and evaluate after the consultation if a derogation or a longer transition period (7 years proposed) should be maintained with a clear and narrow scope reflecting the challenges in term of substitution.

[51] 'Deep drawing' - process of forming sheet metal by using a punch to radially draw the metal into a forming die. The mechanical action of the punch in combination with the hollow die applies both tensile and compressive forces that transform the shape under high pressure; 'broaching' - machining process that uses a toothed tool (a broach), to remove material; 'fine blanking' - high precision metal forming process used in the automotive, heavy duty, electronics, medical sectors.

(producers of PVC; sealant and adhesives; rubber; and paints and coatings) as alternatives are reportedly available for these uses.

97. Based on the above discussion, clearly a full prohibition of the production and use (with no exemptions) of MCCPs would not be the most appropriate control measure, as this may negatively impact a number of key uses, where alternatives are not currently available.

Restriction (Listing within Annex A or B of the Stockholm Convention with specific exemptions/acceptable purposes)

98. Given that Parties and Observers have reported uses where alternatives have not been identified at this time and/or where there are technical challenges associated with the transition to alternative chemicals or processes (as demonstrated through the above discussion), the listing of MCCPs in Annex A, with specific exemptions, or under Annex B with acceptable purposes could be considered the most appropriate control measure. This would facilitate the elimination of production and use of these substances at the global scale for most uses, but allowing continued use for a small number of specific applications where demonstrated to be appropriate, and encouraging substitution in these applications. This would be dependent on ensuring the release of MCCPs from continued production and use can be adequately controlled.

99. If specific exemptions are granted for MCCPs, the development a guidance document on BAT/BEP could be considered. This would enable Parties that have a specific exemption and/or acceptable purpose to take measures to ensure that any production or use under such exemption or purpose is carried out in a manner that prevents or minimises human exposure and releases to the environment. If specific exemptions are granted for MCCPs, the development a guidance document on BAT/BEP could be considered.

100. As outlined in Section 2.1 production of MCCPs varies globally, with net transboundary trade of both the technical CP mixtures, and products likely containing MCCPs expected to occur between regions, particularly between Asia (China and India) and Europe and USA. As the largest producing regions, China and India are net exporters to other regions; while Japan, South America and Africa are net-importers. Additionally, the structure of these producing countries varies significantly. Based on Chen et al. (2022), North American and European producers are typified by a relatively smaller number of large sized companies. Production in Asia (China and India) is more diverse with a larger number of producers spanning different sizes from Small-Medium sized enterprises (SME companies) to large sized producers. The global emission inventory compiled by Chen et al. (2022) estimated potentially higher manufacturing emissions in China on the basis that this greater diversity of producers could also reflect a greater diversity of emission abatement in use and sophistication of that abatement.

101. When CP are incorporated as additives in PVC, rubber, paints or sealants and adhesives, releases can be controlled at the production sites if sound management of chemicals and BAT/BEP are employed to control vapours, liquids and processes. A Stockholm Convention listing could act as the catalyst for upgrade of abatement options for manufacture and consistent emission controls globally. This could also lead to improvements in abatement during compounding of MCCPs within PVC and rubber, particularly in cases where manufacture of both occurs on the same site or nearby locations.

102. The estimation of emissions (see Section 2.1) highlights a possible difference between the type of release (i.e. environmental compartment) observed for manufacture of CPs, and the use of CPs within industrial settings for applications such as PVC, rubber, metal working fluids, and sealants and adhesives, etc. Chen et al (2022) suggests that the primary release vectors for manufacture of CPs are air and soil, while for use within industrial settings water is the primary vector. Guida et al. (2020) expand upon this issue, noting that manufacture of CPs is carried out without significant wastewater discharge. The bigger issue relates to volatilisation and dust drift, meaning the soil around production sites can become contaminated. Control measures should therefore focus on air abatement and strict control of dust drift to protect environmental release. The Annex F submissions from CPIA and WCC (2022) provide feedback from the US EPA risk assessment, noting that for use of MCCPs in PVC, rubber, metal working fluids, and sealants and adhesives, the major release pathway is to water / wastewater, with comments that standard municipal wastewater treatment is likely not to be effective.

103. These releases are associated with losses from mixing vessels, spillages, and primarily cleaning of equipment and containers. For metal working fluids, this also includes cleaning of the finished pieces to remove excess fluid from the surface of finished metal. The responses from CPIA and WCC (2022 Annex F submission) suggest that these releases can be controlled with additional focus on the specific issues including: good maintenance of equipment to limit/prevent losses, and/or containment options to capture any spillages. Furthermore, this could include avoiding cleaning of drums/totes used to deliver MCCPs onsite (instead sending them for specialist cleaning and decontamination), and cleaning of other equipment using approaches which limits the use of water as far as possible. It is noted that the Chlorinated Paraffins Industry Association (CPIA) has prepared a handbook to promote the environmentally safe management of used metal working oil.

104. The Annex F submission from Qatar comments on upgrade of abatement controls for manufacturing of CPs within the country including air pollution control systems (APCS) such as bag filters, wet scrubbers, NaOH/Alkali

injection, and use of active carbon filters. These approaches are aimed at targeting management of volatised CPs and in particular capture and control of fine dusts. The submission from Qatar also comments that monitoring studies will be undertaken for soils and sediments around the manufacturing facilities of CPs.

105. Furthermore, the EU best available techniques (BAT) reference documents provide details on types of abatement equipment and costs to help manage releases for the organic chemical manufacture sector. This could be assumed to represent the most sophisticated BAT/BEP options for release. Table 2.6 provides further details of the possible abatement technologies. In practice, it can be expected that actual CP manufacture will be covered by a full range of release controls (ranging from no/limited control to highly sophisticated control), spanning approximately up to 285 CP producers globally[52].

Table 2.6. Potential abatement technologies for minimising emissions of chemicals (that could be applied to MCCPs during manufacture)) (values in US dollars – original reference in euros)

Technology	Description	Cost
Waste gases / air		
Cyclone technologies	Cyclones use inertia to remove particles from the waste gas stream, imparting centrifugal forces, usually within a conical chamber.	\$1,300 per cyclone per 1,000 Nm^3/h (Capital costs) \$220 per 1,000 Nm^3/h (Operating costs).
Electrostatic precipitator technologies	An electrostatic precipitator (ESP) is a particulate control device that uses electrical forces to move particles entrained within a waste gas stream onto collector plates. The entrained particles are given an electrical charge when they pass through a corona where gaseous ions flow. Electrodes in the centre of the flow lane are maintained at a high voltage and generate the electrical field that forces the particles to the collector walls. The pulsating DC voltage required is in the range of 20–100 kV.	\$55,000 – 550,000 per 1,000 Nm3/h (Capital costs) \$0.06 – 0.11 per 1,000 Nm^3/h (Operating costs)
Bag filter	Fabric filters, often referred to as bag filters, are constructed from porous woven or felted fabric through which gases are passed to remove particles. The use of a fabric filter requires the selection of a fabric suitable for the characteristics of the waste gas and the maximum operating temperature.	\$32,700 – 59,950 per 1,000 Nm^3/h (Capital cost) \$1,090 (Operating cost per hour)
Wet scrubber	Wet scrubbing (or absorption) is a mass transfer between a soluble gas and/or dust in a solvent – often water – in contact with each other. Physical scrubbing is preferred for chemical recovery, whereas chemical scrubbing is restricted to removing and abating gaseous compounds. In physicochemical scrubbing, the compound is dissolved in the absorbing liquid and is involved in a reversible	\$500 – 37,800 per 1,000 Nm^3/h (capital cost). Varies depending on type of scrubber fibrous packing is the least expensive option (\$500 – 1,500) packed bed is the most

[52] The Information document to the MCCPs risk profile (see UNEP/POPs/POPRC.18/INF/11) comments that Chen et al (2022) and Li et al (2018) estimate around 100-150 CP producers in China. By extrapolation on production rates this would suggest around 70-90 producers in India. EU registrations suggests up to 10 producers in the EU. A total of five producers have been identified in North America. Chen et al (2022) estimates that Russian production makes up 7% of global rates (equating to 10-20 producers). Brazil is also known to produce CPs but at lower quantities, again by extrapolation it could be estimated to have around 10 producers.

	chemical reaction, which enables the recovery of the gaseous compound.	expensive option ($7335 – 37,800) $840 – 33,800 (Operating cost per hour) Again, varies depending on scrubber type.
NaOH/Alkali Injection	Neutralisation of waste gases through the adjustment of wastewater pH neutral by the addition of chemicals. For example, sodium hydroxide (NaOH) or calcium hydroxide ($Ca(OH)_2$) is generally used to increase the pH. The precipitation of some substances may occur during neutralisation.	Up to $55,000 per 1,000 Nm^3/h (Capital cost) although strongly dependent on application. 3-5% of investment cost (Operating costs per 1,000 Nm^3/h)
Wastewater treatment		
Onsite wastewater treatment works	Onsite wastewater treatment works act as a form of pre-treatment to address complex chemical loads with different properties. The function of the works is primarily to separate chemical substances from wastewaters (filtration, adsorption, precipitation) and neutralise corrosive properties.	Varies strongly on size and throughput of production plant.
Adsorption (Activated carbon)	Activated carbon adsorption is applied to remove organic contaminants, mainly those with refractory, toxic, coloured and/or odorous characteristics, and residual amounts of inorganic contaminants. Granular medium filters, e.g., sand filters, are commonly used upstream of the activated carbon adsorber to remove the suspended solids present.	$55,000 – 1,090,000 (Capital costs) $1.3 – 2.2 per kg of active carbon, plus $0.11 – 0.6/kg waste management of spent carbon (Operating costs)
Filtration	Filtration describes the separation of solid particles from wastewater effluents passing through a porous medium. This technique is usually combined with the sedimentation of solids or flotation. Filters typically require a cleaning operation, i.e., backwashing, with the reverse flow of fresh water and the accumulated material returned to the sedimentation tank.	$620 – 2,340 per m^2 of membrane (Capital costs) $0.11 – 0.16 per m^3 of permeate produced (operating costs)

Reference: European IPPC Bureau (2017 and 2022) Best Available Techniques (BAT) reference document for common waste gas management and treatment systems in the chemical sector. 2017 published version, and 2022 published draft update.

106. MCCPs are further used within industrial settings for a range of applications. For the use of MCCPs within metal working fluids, a distinction should be made between high temperature and extreme pressure applications (e.g., deep drawing, broaching, etc) and other metal working applications (cutting and sawing, etc) which require less intensive conditions.

107. For the high temperature extreme pressure applications (used to produce e.g., metal fasteners for aircraft), the Annex F response from the CPIA (2022) comments that, due to the high temperature and pressures used, the MCCP applied is largely destroyed through dechlorination, with chlorine atoms incorporated into the surface layers of the metal. The CPIA (2022 Annex F submission) comment that approximately 3,600 tonnes of MCCP are used annually in the USA for metal working fluids, but specific details around how frequently fluids are replaced have not been provided. As indicated earlier in this section, a bigger potential issue is release to wastewater. However, it is noted that insight into release to the environment from MWFs is based on a relatively small number of installations in one global region. The situation in other global regions is unclear [and further information will be sought from Parties and Observers].

108. The CPIA (2022 Annex F submission) comment that the standard risk assessment completed by the US EPA (in 2015) assumes that all releases go directly to sewer without pre-treatment on site first. Based on a survey of their members (2022), they believe that all metal working sites are subject to environmental regulation and that waste waters are collected for management as hazardous waste at off-site wastewater treatment plants. The EU REACH Restriction (2021) identifies metal working as one of the biggest sources of environmental release (along with formulation and use of sealants and adhesives). A key issue is that losses to wastewater and sewer, are sent to municipal wastewater treatment works, which are unlikely to adequately treat MCCPs. The Annex XV dossier does however also state that these releases can be limited if BAT/BEP abatement processes are followed (i.e., onsite pre-treatment of wastewaters). The CPIA further comment that additional analysis is needed to determine what proportion of MCCPs are destroyed during high temperature extreme pressure metal working processes, and what proportion remain within wastewaters. [A mass-balance based on the frequency of MWF change would be useful here].

109. MCCPs are used as mixtures or within finished articles for professional and consumer uses. During the normal use of these mixtures (e.g., sealants and paints) and articles (i.e., PVC and rubber in active service life) it is possible for further emissions to the environment and direct/indirect exposure to occur as described in section xx. . Based on the Annex F submissions specific exemptions for uses within aerospace and defence, and medical applications could be considered on the basis that safety critical applications will have stringent regulations and approval systems with longer lead-in times for substitution (e.g., 10+ years). Options to limit emissions during service life for these applications is very limited. However, the nature of the applications is more niche and represent a smaller fraction of the overall professional / consumer emissions of MCCPs in mixtures and articles as the bigger issue being appropriate management of these articles at end of life.

Unintentional Production

110. As noted by a number of Parties (Section 2.2), the presence of MCCPs congeners that are in the scope of this proposal are potentially present in commercial CP products that are not be within this scope (e.g LCCP-containing commercial products), would not constitute '*unintentional production*' in the context of the Convention. CPs are considered UVCBs, therefore if MCCPs congeners are present in a CP commercial product that is considered outside the scope of this proposal as this is not considered an 'impurity' in commercial CP products.

111. As highlighted by the EU (2022, Annex F submission), the presence of CPs with C_{14-17} in LCCPs at concentrations above 0.1% wt. should not be considered as the result of an 'unintentional' trace contamination, but due to feed-stock selection to produce the LCCPs. Therefore, listing under Annex C is not expected to be the most effective control measure here. While a listing within Annex A (or B) of the Convention would formally identify MCCPs as a POP and eliminate production of MCCPs, the 'unintended presence' of MCCPs within other CP mixtures could be addressed through controls on production. The EU (2022, Annex F submission) suggest that releases could be minimised if the risk management measures under the Stockholm Convention are clearly targeted at all substances containing the C14-17 chloroalkanes congeners of concern above a certain concentration threshold.

112. The carbon chain length distribution of a CP product reflects the carbon chain length distribution of the parent hydrocarbon feedstock. As the manufacturers can select the parent hydrocarbon feedstocks used for the manufacturing of CPs, the presence of $C_{16–17}$ CPs congener groups with POP properties in LCCP-containing products can be controlled and limited.

113. In Europe ECHA is proposing a concentration limit of 0.1 % (w/w) for restricting the presence of chloroalkanes with the $C_{14–17}$ chain lengths with PBT and/or vPvB properties in substances, mixtures and articles. EU (2022, Annex F submission) noted that stakeholders did not raise any issue with the proposed limit indicating that a concentration of 0.1 % (w/w) of CPs with $C_{14–17}$ chain lengths could be achieved in substances, mixtures, and articles. Based on a recent survey of the LCCPs REACH registrants, there are no other LCCP products that contain C_{14-17} constituents above 0.1% w/w in Europe. Information has not been provided for other global regions.

114. To control/limit the 'unintentional presence' of MCCPs in other CP products, manufacturers will need to change the way that CP products (i.e LCCPs) are manufactured, for example by having a good understanding and control of the chain length of the paraffin feedstock. Based on the input from the CP industry (CPIA/WCC, pers. comm, 2022), controlling the chain length of the feedstock may be more feasible in the USA and EU, but may present more of a challenge in Asia (e.g. China and India) - where the bulk of production is now occurring – because, as indicated in earlier sections, they do not base production on feedstock chain length but rather the viscosity/chlorine content. This could present a challenge for some Parties to implement this as a control measure, and also in the enforcement and monitoring of a restriction. It also appears that the downstream users of LCCPs do not have information regarding the composition of the chloroalkanes they purchase, and therefore may not know if the substance contains $C_{16–17}$ CPs congener groups with POP properties, or not (ECHA 2022).

115. The EU (2022, Annex F submission) notes that other process issues such as cross contamination from one manufactured batch to another may also affect the presence of CPs with $C_{14–17}$ chain lengths, therefore controls or development of BAP/BET would support the implementation of this control measure. Given that it is feasible to manufacture LCCPs containing less than 0.1% by weight of C_{14-17} chloroalkanes, a listing under the Stockholm

Convention that includes control measures for C_{14-17} chloroalkanes above of 0.1% (w/w) could be appropriate to avoid divergences on the interpretation/ implementation of note (i) in Annex A.

Stockpiles and Wastes

116. Under Article 6(1) of the Stockholm Convention a listing of a substance within the Annexes of the Convention triggers specific obligations for the identification and management of affected wastes. This would require ratified parties to include details of how MCCP-containing waste would be managed as part of National Implementation Plans (Article 7). However, this would likely include the need for targeted monitoring campaigns and enforcement activities to carefully manage waste and prevent mismanagement which could lead to emissions.

117. As discussed above, when CP are incorporated as additives in PVC, rubber, paints or sealants and adhesives, releases can be controlled at the production sites if sound management of chemicals and BAT/BEP are employed at the site to control vapours, liquids and processes. For use in industrial settings such as metal working fluids, the nature of the application means that mixtures are rapidly converted to wastes and require appropriate management practices.

118. A key area of concern relating to the release of MCCPs is for professional and consumer mixtures and articles with longer service lives and impacts on, for example, the separation and appropriate management and disposal of waste streams. Broadly, the use of MCCPs within PVC and rubber applications can be grouped into four categories: firstly, the use within electrical applications across a range of sectors, where PVC is used in cabling and moulding for electrical articles and applications; secondly, the use within construction applications including internal fittings and power distribution; thirdly within transport applications (vehicles, trains, planes, and shipping); and finally within consumer articles (such as footwear).

Depending on the application, service life can be as little as two years or less (footwear) and as long as 25 years or more (construction). Chen et al (2022) comment that, for in-use stocks of MCCP-containing articles, 78% are PVC applications with service lives of 15 years or greater. Additionally, based upon the EU REACH Annex XV restriction proposal (ECHA, 2022) working concentrations within PVC are in the range of 10-20% wt/wt. and it is suggested that 78% of the 7.4-9.6 million tonnes of in-use MCCPs reside within PVC applications. Chen et al. (2022) estimates that the total volume of PVC material containing MCCPs waiting to enter the end-of-life phase is as much as 96 million tonnes (as a worst case), which will ultimately enter the waste phase with electrical, household, and construction waste. Separation and appropriate management of such waste, particularly without labelling/easy identification is likely to represent a very significant challenge to waste management practice.

119. In terms of incineration, the EU (2022, Annex F submission) assumes that incineration in state-of-the-art facilities with waste gas treatment fully destroys MCCPs (EU Commission, 2005, EU Commission, 2020). However, due to the chlorine content, there is also the possibility that hazardous substances (e.g. polychlorinated dibenzodioxins (dioxins) and polychlorinated dibenzofurans (furans)) can be formed if incineration is conducted at low temperatures (< 900°C) (McKay, 2002). Studies in lab-scale furnaces suggest that other hazardous compounds can also be formed, such as aromatic and chlorinated aromatic hydrocarbons (low-chlorinated chlorobenzenes, polychlorinated biphenyls, and polychlorinated naphthalenes)[53] (Xin et al., 2017, Xin et al., 2018).

120. As the formation of hazardous transformation products depends on the conditions of incineration, it is not possible to quantify the extent to which these products are formed in standard waste incinerators in practice, as the type of facilities is expected to vary considerably between global regions. Similarly, from a regulatory perspective, emissions of other pollutants may be controlled by national-level legislation. For example, in the EU, the Industrial Emission Directive imposes strict limits on the emission of all harmful pollutants from waste incineration plants (Commission Implementing Decision (EU) 2019/2010).

121. In terms of recycling activities, according to Geyer et al. (2017), the global use pattern for PVC is dominated by building and construction (69%) with smaller volumes in industrial machinery (12%) and electrical/electronic (8%). PRE (pers. comm, 2022) indicate that due to the specificities of the collection and treatment steps shorter cables arising from industries such as automotive are, are not recycled at the scale of the cables that are taken from building and construction.

122. In construction/demolition, cables are typically separated and sent to specialised facilities for copper (and aluminium) recycling where cable choppers or cable strippers recover metals and produce a residual waste fraction consisting of other materials such as PVC, polyethylene, polyurethane, and other polymers. The flexible PVC is typically separated using, for example electrostatic sorting magnetic and eddy current separation technology, or micronisation. The residual PVC waste will therefore have a relatively high MCCP concentration, as the other materials have been removed. The resulting flexible PVC is typically used for non-consumer facing applications such as road furniture. input from Plastic Recyclers Europe (2021, pers, comm) suggests that currently there are no separation techniques to identify which cable sheeting flake contains MCCPs and which do not, nor are there

[53] maximum yield at 500–600 °C

technologies to separate the MCCPs from the polymer. As such, it is expected that the recycled material will contain MCCPs. This will present practical and economic challenges with regards to appropriate control measures for handling of wastes, and this may differ between different sectors.

123. PRE (pers. comm, 2021) note that if recycling of the cable sheeting fraction from copper recyclers is not feasible, normally the alternative option would be disposal of these materials in landfill, as incineration facilities tend to not accept wastes with such high levels of PVC/chlorine. Hence this waste may have environmental release associated that is comparable if not higher than when used in a new recycled article. However, if listed under the Convention, a Low POP Content Limit (LPCL) would be set. If the MCCPs in the cable sheeting fraction exceed a set LPCL then legally the waste must be directed towards incineration, creating a situation where legally the cable sheeting must be sent for destruction in incineration but incinerator facilities not accepting the material. There may be significant practical and/or economic implications for incineration facilities, which may lack the capacity to handle such large volumes of waste, or may need to significantly ‘dilute’ waste stream containing PVC to be able to handle this waste.

124. According to input from the PRE (2021, pers. comm), in certain sectors, e.g. WEE in the electronics and ELVs in the transport sectors, where the residual waste from cable recycling is likely to have much lower MCCPs concentration (as other materials and polymers are typically not removed prior to ultimate disposal), this waste is already expected to go to incineration due to the to the exceedance of the LPCL for PBDEs). The implications of listing MCCPs under the Convention on the waste handling for MCCP-containing wastes in these sectors may not therefore represent a significant change.

Analytical methods, enforceability and monitorability

125. The EU (2022 Annex F submission) notes that enforcement of a restriction/ban on MCCPs (as defined in this risk management evaluation) the enforcement of the ban could be foreseen using one of the following methods: manufacturer/producer/downstream user industrial site inspections; spot checks of imports (e.g. by the customs); retailers site inspections; retailers/social media website inspections.

126. As discussed in the risk profile, the highly complex nature of CPs means that there are considerable analytical challenges associated with their detection and quantification. This risk management evaluation covers a range of C_{14-17} chloroalkane congener groups which are complex and variable groupings of constituents with the same molecular weight. While this presents a challenge for ensuring compliance with a restriction on production and use of a defined range of substances based on chain length and degree of chlorination, it is noted that the same issue was raised in relation to the listing of SCCPs in relation to their complex chemistry (chain length and degree of chlorination. The identification and quantification of congener groups in CP products requires highly advanced analytical chemistry equipment and techniques that are typically found only in dedicated academic laboratories or laboratories with a long history of CP analysis and chromatography expertise.

127. The analysis of CPs requires elaborate analytical methods and representative analytical standards (Schinkel et al (2018). As noted by the EU (2022 Annex F submission), it appears evident that advanced techniques enabling a sufficient selectively in the identification and quantification of groups of congeners having the same carbon chain length and chlorination level (i.e. chlorinated alkanes: C_{14-17}) are now available and it is considered that is feasible using available laboratory testing techniques. As discussed in the MCCPs RP (UNEP/POPS/POPRC.18/11/Add.3), the most common methods for quantifying “MCCPs” at a homologue and congener level are LC-API-HRMS[54], GC-ECNI-HRMS (including direct injection APCI-HRMS) and GC-ECNI-LRMS, respectively. Each of these analytical methods corresponds to the following form of evaluation pattern deconvolution, homologue specific, and linear regression, detailed in Bogdal et al., (2015), Yuan et al., (2017a) and Chen et al., (2011), respectively.

128. However, a number of challenges have been noted, which affect the feasibility of these analytical techniques in practice, when it comes to implementing a ban or restriction on MCCPs. For example, while it is noted that recent analytical advances (e.g., high-resolution mass spectrometry, soft ionisation techniques, and innovative quantification methods) now allow the analysis of complex mixtures of MCCPs and LCCPs, it is also considered that suitable analytical standards are still missing, impeding investigations of their environmental fate and risks (Schinkel et al (2018). It is indicated that in practice the detection of MCCPs in PVC products entering waste handling facilities is very challenging as there are limited laboratory facilities that can test these materials (PRE, pers. comm, 2021).

129. Moreover, it was noted by the EU (2022, Annex F submission) that, in the absence of specific information regarding the manufacturing process, the most advanced analytical methods and techniques will not be able to differentiate signals generated by a specific chloroalkane substance described by an EC or CAS number because it is

[54] LC-API-HRMS: Liquid chromatography-atmospheric pressure ionisation-high resolution mass spectrometry. GC-ECNI-HRMS: Gas chromatography-electron capture negative ionisation-high resolution mass spectrometry. APCI-HRMS: Atmospheric pressure chemical ionisation-high resolution mass spectrometry.

not possible to determine to which substance the constituents detected belong. The CP industry (WCC pers. comm, 2022) suggest that the most practical means of identifying substances for this restriction should be based on the carbon-chain length of the feedstock. However, as noted in other sections of this risk management evaluation, according to the CP industry (WCC, pers. comm., 2022), while producers in some regions (e.g. EU, USA) have good understanding of the starting paraffin feedstock, in others (e.g. China and India), which are now dominating the market, producers may be unaware of the chain length of the starting paraffin. This presents a challenge in monitoring compliance with a ban/restriction.

2.4 Information on alternatives (products and processes)

Overview of alternatives

130. Due to the number of uses of MCCPs, for the purpose of this risk management evaluation, the alternatives identified can be grouped by end use application: PVC products, rubber, and other polymers, textiles and leathers, extreme pressure additives for metal working fluids, paints and coatings, and adhesives and sealants. While, for many applications, alternatives have been identified, it is important to note that no one single alternative has been found suitable for all uses of MCCPs (Danish EPA 2014, UNEP 2016, Öko-institut 2019, ECHA 2022).

131. As outlined in the sections below (based on information on alternatives provided in Annex F submissions to the Committee and review of additional literature) and based on the findings restriction proposal for MCCPs in the EU (ECHA 2022), available alternatives have been identified for MCCPs for each key specific application for these substances. Furthermore, Japan (Annex F submission) has indicated successful identification and implementation of alternatives to specific applications of some uses of metal working fluids, lubricants, adhesives, and maskants, however most alternatives identified are not "drop-in" alternatives and thus, are not able to be used for every application. For example, some applications have additional flammability or other requirements that must be met prior to certification.

132. As discussed by ECHA (2022) and in the EU 2022 Annex F submission, for PVC, technically feasible alternative substances or technologies are available, even though substitution may lead to a slight increase in production costs of PVC compounds. It is also noted that feasibility of substitution/removal may differ between different types of PVC compounds. For other key uses (including rubber, adhesives/sealants, paper, and leather) technically and economically feasible alternatives for these uses are available or are expected to be available such that substitution can be achieved before a restriction is put in place.

133. To transition to any alternative substances, there must be consideration of the health and environmental hazard profiles. The risk of the potential chemical alternative should be fully assessed, including whether the alternative would meet Annex D criteria of the Stockholm Convention. As noted in the General guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals, “although it may be difficult to implement fully risk assessment on alternatives, Parties should at least confirm that persistent organic pollutants are not substituted by others or by chemicals with concern of significant risk" [55].

Alternative substances

PVC and other polymers

134. MCCPs are used in several polymer systems, predominantly PVC products such as cables, with a smaller usage in floors and coated fabrics. The main function of MCCPs in these applications is twofold: 1. As a plasticiser, which is to increase the flexibility of the polymer and 2. As a flame retardant, which is intended to prevent or slow the development of further ignition.

135. LCCPs were thought to be an adequate chemical alternative that provides both plasticisation and flame retardancy, however, further research revealed that in some applications of PVCs and rubbers LCCPs can result in a material that is too brittle for the application, or which has insufficient flame retardancy for others (Danish EPA 2014, Öko-institut 2019). CPs (up to 20 carbon atoms) meet the definition of ‘toxic’ under paragraph 64(a) of the 1999 Canadian Environmental Protection Act, which further limits LCCPs for use as alternatives in some cases within Canada (Canada 2013). However, direct evidence that C18-C20 are toxic is limited. The balance of viscosity to flame retardancy is also a concern with LCCPs, as longer carbon chains result in higher viscosity but the chlorine percentage

[55] The general guidance for assessing alternatives can be found here:
http://chm.pops.int/TheConvention/POPsReviewCommittee/Meetings/POPRC5/POPRC5Documents/tabid/592/Default.aspx (UNEP/POPS/POPRC.5/10/Add.1).

may need to be decreased to bring the viscosity back into the working limits of the material, sacrificing flame retardancy (ECHA 2022). Weingart et al. (2018) has recently presented developments in chlorinated methyl esters (CMEs) which have shown some promise in PVC applications as both a plasticiser and a flame retardant, with claims that CMEs readily biodegrade; however, there is no further information available regarding this (Weingart et al., 2018, ECHA 2021).

136. The phthalates diisodecyl phthalate (DIDP) and diisononyl phthalate (DINP) exhibit technical advantages compared to MCCPs as plasticisers for PVC, however, they lack the flame-retardant properties MCCPs provide (Danish EPA 2014, Entec 2008, Zarogiannis, 2010). DIDP and DINP, along with other *ortho*-phthalates, are restricted under EU REACH for applications where the article is a toy or childcare article that may be placed in the mouth (KEMI 2019, ECHA 2018, ECHA 2021b). These substances are also included in Canada's Chemicals Management Plan under the phthalates substances grouping, with follow-up activities planned to track changes in exposure and commercial use due to the associated health and/or ecological concerns (Canada 2022b). The cost for DIDP and DINP are roughly double that of MCCPs (€1650-2000 €/per tonne versus €650 per tonne respectively) (KEMI 2019). Non-ortho-phthalate plasticisers, such as di(2-ethyl-hexyl) terephthalate (DEHT), octadecanoic acid butyl ester, and di-isononyl-cyclohexane-1,2dicarboxylate (DINCH), can substitute MCCPs for the plasticising effect at a higher price, again these alternatives lack flame-retardant properties (Maag et al. 2010).

137. Flame retardant alternatives such as phosphates, aluminium hydroxide, aluminium polyphosphate and other chlorinated or brominated compounds must be used in conjunction with plasticiser alternatives mentioned above in order to achieve both the flame retardation and plasticising properties of MCCPs for plasticised PVC (Danish EPA 2014). Further analysis of the environmental and health risks would be needed to assess the suitability of these as alternatives. The costs associated with using a combination of alternative plasticisers and flame retardants is a 40-60% increase as compared to MCCP costs (Danish EPA 2014). The cost of the aforementioned flame-retardant alternatives varies from 600€/tonne for aluminium hydroxide to an excess of 3000€/tonne for many of the phosphate alternatives (KEMI 2019). This cost, in addition to the need for a plasticising alternative as well, is a significant increase over MCCPs.

138. For PVC uses, Kemi (2016) indicated that, in electronic cable applications, MCCPs can be substituted, and technically feasible alternatives can be found. However, it is unlikely that one single substance can substitute the MCCPs across all of its uses since MCCPs function as both a plasticiser and flame retardant. Canada (Annex F submission) noted that, although technically feasible, the use of alternatives may increase the raw material costs for manufacturers. It is also noted by Miljogiraff (2021) that a Life Cycle Assessment of PVC cable insulation with MCCP and alternatives (DINP, antimony oxide and DIDP, antimony oxide) indicated that MCCP has lower environmental impact than the alternatives, in all impacts. However, this did not include a consideration of PBT properties, which is a key consideration in the risk management options in the context of the Convention. Concern about the compatibility of existing plastics with MCCPs versus future alternatives has been noted, specifically surrounding the electrical cabling sector (Japan 2022). As electrical cabling is used for a long period of time and repaired when needed, poor compatibility between the polymer sheathing once alternatives are introduced could lead to an inability to perform repairs as weak points in the cable sheathing can occur, and therefore end the service life of the electrical article early, creating larger amounts of electrical waste (Japan 2022). While some alternatives are available, they must be implemented at the beginning of the service life of the electrical article, as the issue is mainly around cabling repairs when new cabling is spliced onto old cabling to repair a defect in the cable sheathing or restore connection. One EU company indicated that the substitution appears to be challenging in specific types of cables, which need to comply with the more stringent fire performance requirements set out in Regulation (EU) No 305/201128, specifically, the EN 50399 tests (which tests for fire characteristics of cables such as flame spread, power generation, smoke formation, and burning droplets as is the basis for CE marking)required for copper clad aluminium (CCA) types of cables (ECHA 2022).

139. When considering other polymers, such as natural and synthetic rubbers, the majority of alternative considerations are based on the substitution of SCCPs and not MCCPs (ECHA 2021). The primary function of MCCPs in rubbers is flame retardancy due to the inherently flammable nature, and a number of suitable alternatives have been proposed. UNEP suggests inorganic compounds such as aluminium hydroxide, and phosphate containing compounds (UNEP 2016). However, it is noted that for some applications, such as conveyor belts and fireproof doors and bellows for buses/trains, these alternatives are not sufficient, and no other alternatives have been found to have the same quality or dual functionality as MCCPs (ECHA 2021, Environment Agency 2019).

140. In the EU, substitution activities in this sector are ongoing and are in the final stage for most of the products (ECHA, 2022). Some companies producing rubber conveyor belts for underground activities, which need to meet several European standards[32], have already started research and development activities to find substitutes and consider LCCPs suitable (EC No 264-150-0, with carbon chain lengths C22-30) (ECHA 2022). LCCPs also appears to be the alternative of choice for other rubber products that have to meet strict conditions of use in terms of fire resistance and safety, for example in the transport sector (ECHA 2022).

141. In addition to LCCPs, several phosphate-based flame retardants were identified as potential alternatives in rubber conveyor belts by some stakeholders interviewed by ECHA in the context of the REACH restriction proposal– among which phenol, isopropylated, phosphate (3:1) (EC 273-066-3) and tricresyl phosphate (TCP) (EC 215-548-8) – may be considered as technically feasible substitute (ECHA 2022).

142. For other types of rubber products alternative flame retardants also appear to be available and, as indicated by the European Tyre & Rubber Manufacturers Association (ETRMA), the industry has identified suitable alternatives and is prepared to begin substituting in industrial production (ECHA 2022).

Metal working fluids

143. Alternatives for MCCPs in metal working fluids pose a challenge due to the extreme environments these fluids are used in, such as tapping, rimming, boring, broaching, extrusion, and pilgering (Environment Agency 2019).

144. The metal fastening industry in the USA has stated that there are no alternatives to MCCPs for metal working fluids in a number of specific uses (WCC-CPIA 2022). The Annex F response from Japan also echoed this sentiment, as did the response by Special Metals Wiggins during the UK request for comments on the proposal to list MCCPs under the Stockholm Convention in 2021 (Japan 2022, Special Metals Wiggins 2021). As metal working fluids are formulated to target specific end use applications, finding any simple drop-in alternative may be challenging and alternatives may have to be examined on an end-use basis.

145. ECHA (2021) concluded that alternatives for metal working fluids appear to be available, noting however that at this stage, it is not certain whether they are technically able to replace MCCPs in all metal working fluids used and in particular in heavy duty working operations. Canada (Annex F submission) noted that available alternatives are identified in Canada, but some substitutes may not be technically suitable for all applications and may be more costly as they are expected to incur reformulation costs, as well as increased operating costs. Japan highlighted in their Annex F submission that MCCPs function as an extreme pressure additive for 'heavy-duty' processing in metal working fluids, for which it will be challenging and time-consuming to find a technically suitable substitute.

146. In 2012 Dover Chemical Corporation released marketing material detailing greener alternatives to extreme pressure lubricants such as MCCPs. These alternatives include sulphurised hydrocarbons, phosphate acid esters, chlorinated fatty esters and acids, as well as phosphorous-containing blends and nitrogen containing compounds, many of which are still produced and available for purchase (Dover, 2023). Further work has been done on incorporating vegetable-based fluids into oil- and water-based lubricants to develop Environmentally Adaptive Lubricants (EALS). However, there is no information as to whether these alternatives are suitable to replace MCCPs across all applications (UNEP, 2022).

147. Phosphorus- and sulphur- based additives work in a similar way to MCCPs, as there is an activation of the additive when the metal surface reaches a specific temperature, and the released salt prevents welding of metal surfaces through lubrication (United Kingdom 2008, ECHA Annex F 2022). Phosphonates have "excellent performance" in high temperatures, and when combined with calcium and sodium sulfonates with sulphurised esters the performance can match that of MCCPs (Environment Agency 2019, ECHA 2021). However, acid alkyl phosphates are difficult to work with due to their acidity and come at a higher price, while zinc dialkyl dithiophosphate can leave a burn residue when used at high temperatures (ECHA 2021). Sulphides as solids are promising, as viscosity is constant until the melting point, but are limited in high temperature applications due to poor solubility and have an intense odour (United Kingdom 2008).

Textiles and Leathers

148. Within textiles, the majority of information regarding alternatives is focused on substituting SCCPs. Since both SCCPs and MCCPs are used in similar applications, it is suggested that MCCPs could be substituted with similar alternatives. CPs are primarily used as flame retardants, of which many suitable compounds have been identified, such as brominated flame retardants (allyl 2,4,6-tribromophenyl, dibromostyrene, tetrabromophthalic anhydride).

149. Within leather, fat liquors MCCPs are not considered essential to the performance of the application, with the EU working to phase out MCCPs and other countries such as the UK completely phasing out their use. Alternatives, such as sulphurised animal and vegetable oils have been suggested (Entec 2008, ECHA 2021).

150. Although many types of fat liquors are available in the market, CPs appear to be used in fat liquor products that need to provide a particularly high degree of softness to leather, as well as water and tear resistance (ECHA, 2022). 'Paraffin waxes and Hydrocarbon waxes, chloro, sulfochlorinated, saponified (CAS No. 1469983-39-8)' is currently used in fat liquors in the EU. This substance may contain MCCPs in concentration varying between below 0.1 % and up to ca. 10 %., depending on the grade of the feedstock (presence of MCCP) used and on the amount of alkane that would be chlorinated but not sulfonated. Some users of the fat-liquoring substance 'Paraffin waxes and Hydrocarbon waxes, chloro, sulfochlorinated, saponified' confirmed that the substance they use contains <0.1 % of MCCPs (also confirmed that their suppliers are indeed already using an alkane/alkene feedstock with <0.1 % of

MCCPs). Therefore, it is expected that companies that may be currently using the substances containing more than 0.1 % of MCCPs chloroalkanes will shift to compositions containing <0.1 % of MCCPs (ECHA, 2022).

Paints and Coatings

151. Within paints and coatings, MCCPs are used in industrial settings as marine and anti-corrosion coatings due to their ability to increase the hydrophobic nature of the paint or coating, as well as act as a plasticiser (ECHA 2022). Due to this, few alternatives have been identified that allow for a simple substitution. In acrylic topcoats, polybutenes have been suggested to replace MCCPs (Environment Agency 2019). However, further information about the technical feasibility of MCCP alternatives is limited when it comes to underwater applications.

152. Based on the information provided by coating producers in the context of the REACH restriction proposal, it appears that substitution is ongoing in the EU and, technically and economically feasible alternatives are available, and some of the major players in the EU market have already phased out the use of MCCPs in marine and protective coating formulations (ECHA, 2022). Acrylic- and epoxy-based primers have been suggested as a suitable substitute for underwater paint applications where paints that contained MCCPs have been traditionally used to reduce corrosion on underwater metals (Environment Agency, 2019).

153. MCCPs are also used as viscosity modifiers and adhesion promoters in coatings (ECHA 2021). Polyacrylic esters, diisobutyrate, and phosphates have been suggested as suitable alternatives for MCCPs (Afrim 2021, ECHA 2021). When used for their flame-retardant properties, MCCPs in paints and coatings have been substituted with other flame retardants, such as halogenated compounds or melamine derivatives (Danish EPA 2014). LCCPs (with chain lengths C_{22-30}) are widely used as fire retardant and plasticiser in fire retardant paints and solvent-based intumescent coatings. Because the concentration of chloroalkanes with chain lengths C_{14-17} is expected to be below 0.1 % in LCCPs, companies operating in this sector are not expected to look for any alternative because of this restriction. Nevertheless, if any companies are currently using LCCPs with MCCP concentrations above 0.1 %, these are expected to be able to move to LCCPs containing less than 0.1% MCCPs (ECHA, 2022).

154. The UNEP has reported that thermoplastic products could replace road markings that have CPs in the paints, and while this was recommended initially for SCCPs it is suggested the alternative technology could be extended to MCCP-containing paints (UNEP 2020). The long-term environmental effects of thermoplastics were not discussed.

Adhesives and Sealants

155. Technically feasible alternatives should provide the sealants with the different functions currently provided by substances containing MCCPS. Suitable alternatives (which can include a combination of chemicals) should act as plasticiser, flame retardant and filler, as well as meet a number of physico-chemical criteria. For one-component foams (OCF), alternatives should be non-reactive to isocyonates and meet certain criteria in terms of viscosity, hydrophobicity, solubility etc., in order to be chemically compatible to PU prepolymer system inside the OCF can. Additional criteria and performance requirements may include the ability of the alternative to act as an emulsifying agent and meet the required shelf-life criteria (ECHA, 2022)

156. For insulating glass (IG) polysulfide sealants, any suitable alternative needs to be compatible with the polysulfide polymer technology, provide good adhesion, mechanical properties and UV stability to the sealant and have a very low migration potential (ECHA, 2022)

157. According to the information available in the EU, the substitution efforts in this sector are taking place and potential alternatives appear to be available on the market. However, a drop-in alternative appears not to be available, resulting in the need for product reformulations (ECHA, 2022).

158. With regard to polysulfide sealants, some benzoates (e.g. Oxydipropyl dibenzoate (DPGDB) (EC 248-258-5)33, and phthalates (e.g. Di-"isononyl" phthalate (DINP) EC 249-079- 5) appear to be among the main potential substitutes (ECHA, 2022)

159. Several alternatives, among which tris(2-chloro-1-methylethyl)phosphate (TCPP, EC 237-158-7), appear to be suitable to replace substances containing MCCPs in rigid polyurethane foams (ECHA, 2022). Substitution is already expected to be completed in the EU before 2025 with no additional impacts on the industry (ECHA, 2022).

Alternative techniques

160. For some applications where MCCPs are used as additives, there are alternative techniques that can be used to avoid the use of MCCPs. These techniques are more substantial than simply changing the additive from MCCPs to an alternative substance and can require operational processes to change.

161. All of the alternative techniques discussed here are chemical alternatives, however they reflect a fundamental change in the carrying substance of the MCCPs (e.g., the lubricant base for metal working fluids or the polymer type for other applications).

PVC

162. In some applications where PVC with MCCPs is used, alternative polymer systems can be used instead. Low-smoke free-of-halogen (LSFOH) polymer compounds, such as acrylonitrile butadiene styrene (ABS) systems, or non-halogenated flame retardants in polymers of similar plasticity can be used, with considerations taken for local cable test specifications (of which there may be many) (Shah, 2021). For electrical cable applications, a number of polymer/flame retardant systems have been shown to be effective alternatives for PVC/MCCP systems, as outlined in 2014 Danish EPA report (Danish EPA 2014). Similar polymer/flame retardant systems to replace PVC with MCCPs are suggested in the Oeko-Institut (2019). Of these, some notable alternative systems include inorganic flame retardants (zinc borate, zinc stannate and hydroxystannates, and metal hydroxides), in combination with phosphorus-based compounds (aluminium diethylphosphinate or phosphate esters) and elastomers such as natural rubber, poly-styrene-butadiene rubbers, and silicone rubbers of thermoplastic elastomers have been employed in electrical cables of various voltages (Oeko-Institut 2019).

163. In applications such as flooring and wall coverings, other alternative materials have been suggested in place of PVC (with MCCPs), such as non-vinyl, paper based wallpapers or linoleum or stone tile flooring (ECHA, 2022). It is noted that these aforementioned alternatives may result in poorer performance regarding the longevity or flame-retardancy characteristics of the article.

Metal working fluids

164. Within metal working fluid applications, an alternative water-based technique has been suggested to traditional MCCP-containing additives. Houghton (2023) has shown that a water-based technique can be used, but the 3-4 treatment steps over the traditional single treatment step has not been proven acceptable for commercial applications. Other alternative techniques include the usage of supercritical CO_2, either on its own or with an oil such as soybean, to achieve lubrication under extreme pressures (ECHA, 2022, UNEP, 2016). Dry machining is also an option, where instead of using lubrication fluids, liquified gases and cryogenic machining are used (UNEP, 2022).

Paints and coatings

165. Acrylic- and epoxy-based primers have been suggested as a suitable substitute for underwater paint applications where paints that contained MCCPs have been traditionally used to reduce corrosion on underwater metals (Environment Agency 2019). The 2020 UNEP report suggests that thermoplastic products could replace road markings that have CPs in the paints, and while this was recommended initially for SCCPs it is suggested the alternative technology could be extended to MCCP-containing paints (UNEP 2022). The long-term environmental effects of thermoplastics were not discussed.

Adhesives and sealants

166. Traditional polysulphide sealants that contain MCCPs can be substituted by polyurethane and silicone-base sealants for some applications. Silicone-based sealants have several advantages over polysulphide sealants, such as better UV-resistance, stress recovery, cure rate and lower temperature applicability. While silicone-based sealants have lower performance and less colour availability, they do still hold the largest market share of sealants (ECHA 2022).

167. Potential alternative technologies to polyurethane foams, include mineral wool and pre-compressed tapes. According to the association representing the European adhesive and sealant industry (FEICA), mineral wool needs to be manually inserted and pressed into a joint. Application of this alternative technology requires hours of manual labour compared to a few minutes required for installing an OCF product (ECHA, 2022). Moreover, the association stressed that long-term insulation performance inside a joint with (thermal) movement is unclear as this product does not guarantee the seamless filling capacity as OCF products do (ECHA, 2022). Pre-compressed tapes may also be considered as substitutes, according to FEICA. However, the association explained that the quality of workmanship is much more critical than for OCFs and that insulation values are typically lower when compared to OCFs. Finally, in case of poor workmanship the insulating function of pre-compressed tapes could fail altogether (ECHA, 2022).

Textiles

168. To replace textiles that use MCCPs, alternatives such as inherently less flammable fabrics (wool, modacrylics), leathers or specially designed polymer backbones have been recommended (ECHA 2021).

Summary and conclusion from the assessment of alternatives

169. Several alternatives have been suggested for MCCPs within the various applications and, while alternatives do exist, however, some alternatives, may have potential harmful effects as shown in table 2.7. Alternatives to MCCPs should be selected very carefully to avoid regrettable substitution. Currently, there is no one identified alternative that provides both flame-retardancy and plasticisation to the level that MCCPs do for PVC and polymer applications, and when using two alternative substances in combination to achieve these properties there is an increase in cost. For PVC and other polymer applications the most significant challenge is ensuring the alternatives perform as well as or better

than MCCPs. There is the added challenge of matching polymer compatibility when adjusting the alternatives to ensure current technology, such as cable sheathing, can be replaced to align with the expected service life of the article. PVC and other polymer manufacturers are in a position to begin manufacturing articles with MCCP alternatives from a feasibility standpoint, however making the changes to industrial processes could be a factor in the lead in time for these alternatives to be used. Metal working fluid alternatives pose a separate challenge, as the available alternatives may not be suitable for all current applications as MCCPs are, as is noted above. This requires alternatives to be tested and the changes be made on an end use basis. For leather, the use of MCCPs is noted to be for more niche and specialty applications. Textiles, on the other hand, have traditionally used MCCPs as flame retardant additives, and there are a number of existing and emerging alternatives for manufacturers to use. For paints, coatings, adhesives, and sealants there are many suitable alternatives on the market for MCCPs however reformulation is required to change to these alternatives. Reformulation can be a time consuming and costly process; however, manufacturers have the available information to begin this process. Finding a single, drop-in additive substitution for MCCPs has been noted to be challenging, and from the available information using alternative techniques may be more promising. However, changing to alternative techniques can be costly from an operational perspective and would require manufacturers to make significant changes to their process.

Table 2.7. Summary if information on alternatives

Substance	CAS No.	Application	Purpose of use	Economics	Feasibility	Hazards and limitations	Reference
LCCPs	85535-86-0	PVC and polymers, paint, sealants, adhesives, leather fat liquors	Plasticiser, flame-retardant (at high Cl content)	Slightly higher cost compared to MCCPs	Can be used in some applications	Potentially persistent and accumulative May lead to brittleness in polymer	Danish EPA 2014
Chlorinated methyl esters	Multiple (95009-45-3)	PVC and polymers, metal working fluids	Plasticiser, flame-retardant		More research needed	No notified hazards under EU REACH	Weingart 2018, ECHA infocard
diisodecyl phthalate (DIDP)	68515-49-1	PVC and polymers, paints and sealants (alternative for SCCPs but suggested for MCCPs)	Plasticiser	Potential increase of 40-60% as compared to MCCPs	Compatible in most applications MCCPs are used in	Restricted in entry 52 in Annex XVII EU REACH Will need companion flame-retardant.	Kemi 2019, Danish EPA 2014
diisononyl phthalate (DINP)	28553-12-0	PVC and polymers, paints and sealants (alternative for SCCPs but suggested for MCCPs)	Plasticiser	Potential increase of 40-60% as compared to MCCPs	Compatible in most applications MCCPs are used in	Restricted in entry 52 in Annex XVII EU REACH. Will need companion flame-retardant.	Kemi 2019, Danish EPA 2014
Di(2-ethyl-hexyl)terephthalate (DEHT)	6422-86-2	PVC and polymers, sealants, paints and coatings	Plasticiser		Compatible in some formulation	No flame-retardant properties	Danish EPA 2014

2,3-bis(acetoxy)propyl ester and octadecanoic acid, 2,3-(bis(acetoxy)propyl ester	57-11-4	PVC and polymers	Plasticiser		Drop in plasticiser alternative	No flame-retardant properties	ECHA 2021
di-isononyl-cyclohexane-1,2dicarboxylate (DINCH)	166412-78-8	PVC and polymers	Plasticiser	Low cost	Drop in plasticiser alternative	No flame-retardant properties	Danish EPA 2014, ECHA 2021
Zinc borate	138265-88-0	PVC and polymers	Flame-retardant		Used in PVC and polymers for other applications, however, may need to be combined with plasticiser for the same properties as MCCPs	Toxic to aquatic life with long lasting effects, suspected of damaging fertility or unborn children	Danish EPA 2014, ECHA infocard
antimony oxide [trioxide]	1309-64-4	PVC and polymers	Flame-retardant		Suitable drop in alternative flame-retardant, compatible with many plasticisers	Harmonised classification as carcinogen (cat 2) and evaluation ongoing due to carcinogenicity	ECHA 2021
aluminium hydroxide	21645-51-2	PVC and polymers	Flame-retardant		Used in PVC and polymers for other applications, however may need to be combined with plasticiser for the same properties as MCCPs	No risk to human health, data gap for environmental hazards	Danish EPA 2014
sulphurised hydrocarbons	Multiple	Metal working fluids	Lubricant		Can be used in some applications, but not high		Danish EPA 2014

					temperature applications		
allyl 2,4,6-tribromophenyl ether	118-79-6	Textiles	Flame-retardant		Suitable drop in alternative for textiles	Under PBT assessment	ECHA 2021
dibromostyrene	2039-82-9	Textiles	Flame-retardant		Suitable drop in alternative for textiles	Can cause serious eye irritation and skin irritation	ECHA 2021
tetrabromophthalic anhydride	632-79-1	Textiles	Flame-retardant		Suitable drop in alternative for textiles		ECHA 2021
polybutene	9003-29-6	Paints and coatings	Viscosity modifier, hydrophobicity increased		Possible for acrylic topcoats	Highly flammable liquid, can cause lasting effect to aquatic life	ECHA 2021, ECHA infocard
polyacrylic esters	9003-01-4	Paints and coatings	Plasticiser		Suitable drop in alternative, however, will require flame retardant additive as well	Can cause eye and respiratory irritation	ECHA 2021
terphenyls	84-15-1	Sealants and adhesives	Viscosity modified and increased hydrophobicity		Suitable drop in alternative, however, will require flame retardant additive as well	Terphenyl, hydrogenated has been identified as an SVHC candidate	ECHA 2021
2,2,4-trimethyl-1,3-pentanediol	144-19-4	Sealants and adhesives	Viscosity modified and increased hydrophobicity		Suitable drop in alternative	Eye irritation	Zarogiannis and Nwaogu 2010, ECHA 2021
benzoates	532-32-1	Sealants and adhesives	Viscosity modified and increased hydrophobicity		Suitable drop in alternative	Low hydrophobicity, can lead to higher moisture vapour transmission rate	ECHA 2021

1,1'-(ethane-1,2-diyl)bis[pentabromobenzene]	84852-53-9	PVC and polymers	Flame-retardant		Suitable drop in alternative	PBT assessment is underway	ECHA 2021
tetrabromophthalate ester	77098-07-8	PVC and polymers	Flame-retardant		Suitable drop in alternative	PBT assessment is underway	ECHA 2021
bis (tribromophenoxy) ethane	37853-59-1	PVC and polymers	Flame-retardant		Suitable drop in alternative	PBT and ED properties assessment is underway	ECHA 2021

2.5 Summary of information on impacts on society of implementing possible control measures

Health, including public, environmental, and occupational health

170. Potential impacts of MCCPs on human health and the environment primarily relates to its POP properties (UNEP/POPS/POPRC.18/5/Add.1), and the exposure resulting from its production and use as well as stockpiles, waste management and recycling. Listing MCCPs under the Stockholm Convention is anticipated to have long-term benefits to society by avoiding exposure and risks to human and environmental health from these sources.

171. MCCPs have been measured in human breast milk, placenta, and blood. Environmental monitoring studies have reported widespread detection of MCCPs at varying trophic levels and presence in remote regions including the Arctic. Human exposure to MCCPs has been linked to food consumption and exposure through inhalation and dermal contract with MCCP-containing products. According to a study provided by Sweden in its Annex F submission, dietary intake might be the predominant exposure route to MCCPs and other CPs, contributing a median of 82% of the total daily intake (Yuan *et al.* 2022).

172. MCCPs have been shown to exert significant toxicity to aquatic invertebrates which are an important part of aquatic food chains. Effects on organisms at this trophic level may reduce food availability at higher levels of the food chain with potential population-level effects. Potential adverse effects could occur in wild mammals exposed to MCCPs via their diet. Numerous studies detect MCCPs in food for human consumption indicating dietary exposure. Several monitoring studies also indicate the presence of MCCPs in household dust, a number of household products and appliances, rubber granulates used in playing fields and other sources that may represent exposure pathways to humans.

173. Due to the persistence properties of MCCPs it is recognised that past and current emissions will likely remain in the environment for long periods of time. However, a restriction on the use of MCCPs would provide benefits to human and environmental health by preventing further releases to the environment and reducing exposure.

174. In 2022, ECHA submitted a dossier proposing the restriction of MCCPs where different options were identified and assessed in the EU territory. Any restriction option laid out in this report would reduce MCCPs emissions to the environment. However, emissions would not fully cease as the use and disposal of existing articles containing this substance would continue in any case. Many listed alternatives in Appendix E of ECHA's dossier have no specific concerns identified for human health and environmental hazard and risk. However, some of the alternatives are currently under assessment for a carcinogenic concern and might become included in the EU REACH regulation if this is confirmed.

175. A ban would reduce occupational exposure to MCCPs. Workers in production plants are exposed to MCCPs in the indoor environment for prolonged periods of time each day.

Agriculture, including aquaculture and forestry

176. MCCPs are not used directly in agricultural practices, however, contamination of agricultural soil with MCCPs may occur as a result of land application of sewage sludge and/or deposition of emissions initially to air. This practice may contribute to environmental dispersion or redistribution of MCCPs and contribute to human and environmental exposure.

177. Control measures to eliminate or restrict the production, use, including the incorporation of MCCPs into articles are expected to reduce the levels of MCCPs in sewage sludge. Thus the elimination of MCCPs (i.e. listing in Annex A) would provide the greatest benefit to agriculture, as well as human and wildlife health, by reducing releases to the environment and further accumulation of persistent substances in soil. The inclusion of specific exemptions or acceptable purposes for MCCPs, is expected to result in some (but relatively lower) benefit as the use of MCCPs would be restricted.

178. However, as noted above, a significant proportion of global MCCPs are incorporated in 'in-use' products, e.g. in PVC-containing products (ECHA, 2022). The release of MCCPs, either through direct use, or ultimate disposal into waste streams, could therefore act as an important source of MCCPs to soil and agricultural land in the long term. Control measures that are put in place to restrict the use of and exposure to MCCPs should therefore consider the implications for appropriate waste management.

Biota (biodiversity)

179. The risk profile notes that MCCPs monitoring data generally show their widespread occurrence in surface water, sediment, soil, biota, sludge and air, in multiple regions of the world, including remote regions (UNEP/POPS/POPRC.18/5/Add.1).

180. For example, bioaccumulation of MCCPs has been observed in mussels, rainbow trout and bleak, while CPs have been found in rabbits, moose, reindeer, arctic char, herring, seals (WHO, 1996). Furthermore, it seems that concentrations of MCCPs in biota have increased during recent decades (ECHA, 2022), corresponding with the overall trend in global production and use over the same timescale.

181. The implementation of control measures to restrict the production and use of MCCPs would have a positive effect on biota through the removal of a persistent toxic substance that is known to bioaccumulate in the food chain and cause adverse effects.

182. Control measures that are more restrictive, such as a listing in Annex A without specific exemptions, would provide the greatest environmental and health benefit. Due to the long-range environmental transport of MCCPs, control measures that allow their ongoing production and use may not be adequately protective of biota, including those residing in remote regions such as the Arctic.

Economic and social aspects

183. CP production (for which MCCPs are the majority globally) are considered an integral part of the overall chlor-alkali industry (MCCP REACH Consortium, 2021). This industry produces a number of critical products and feedstocks (e.g. vinyl chloride, hydrochloric acid and sodium hypochlorite). It has been highlighted that the production of CPs makes use of the excess liquid chlorine produced from the chlor-alkali operations. The ability to use excess chlorine onsite not only utilises a waste product, but also negates the need for transporting and storing hazardous chlorine, which is subject to various restrictions. A restriction on the production of MCCPs would therefore lead to the loss of this commercially beneficial process, and would require the waste chlorine to be processed or disposed of via other routes.

184. ECHA has conducted an impact assessment of different restriction options and has identified that a transition period of two years to phase out MCCPs would be considered sufficient for most applications within the EU (ECHA, 2022). This was based in part on direct industry input, information gathered from the ECHA market survey, and experiences of companies that have already substituted MCCPs.

185. The ECHA Annex XV Restriction Report estimates that under the proposed restriction options, that a transition period of 2 years is believed to be sufficient for phasing out MCCPs within Europe for the following sectors; producers of PVC; sealant and adhesives; rubber; and paints and coatings.

186. It was noted, however, that industry responses and the economic impact for the metal working fluids sector would be different and a specific derogation should be considered for this sector. This is to take into account that alternatives may not be readily available for specific extreme pressure metal working fluid applications, and a longer transition period would allow necessary research and development to substitute MCCPs. A longer transition period of 7 years has been proposed for this sector, as the transition period of 2 years was not considered sufficient. A longer transition period was highlighted in the Annex XV report to be justified due to the uniqueness of the remaining process (e.g. heavy-duty metal working). A shorter transition period was noted to potentially halt certain operations dependant on MCCPs in the metalworking fluids sector, and could result in a relocation of impacted activities to outside of the EU.

187. In PVC production, based on the ECHA market survey, when MCCPs are removed from PVC products, an increase in production cost of between 2-4% can be expected due to the costs associated with adapting other components of the formulations. The total estimated costs including one-off reformulation of PVC compounds, research and development and testing, have been estimated at €120 million for all the affected companies (up to 400

across the EU), with an annual increase in variable costs of around €30 million. The Dossier Submitter estimated a total compliance cost of €580 million over a 20-year period.

188. Kemi (2018) assumed that 15,000 tonnes/year of MCCPs are placed on the market in the EU as part of electronic and electrical equipment (EEE). It was further estimated the total increased annual cost per year would be €27 million, when replacing half of the 15,000 tonnes of MCCPs for LCCPs and the other half with a combination of DINP and 2-ethylhexyl diphenyl phosphate. It was further highlighted that by substituting alternative plastic materials such as polyethylene and polypropylene for PVC would result in a 50-200% increase in production costs.

189. The British Plastics Federation (BCF) has previously highlighted in a response to Defra regarding MCCPs, that recycled PVC can also be used to produce a range of products, including in the traffic management and construction industries (e.g. traffic cones, roadside barriers) (British Plastics Federation, 2021). In this same response, BCF have noted that the UK currently has capacity to recycle 50,000 tonnes of cable waste per year from cable sheathing. If PVC had to be incinerated rather than recycled this could negatively impact the PVC recycling industry, where cable recyclers would face relatively high processing costs. This situation would likely be applicable for cable manufacturers not just within the UK, but globally. Furthermore, PVC when incinerated releases hydrochloric acid; it is understood that most incinerators have a low tolerance to chlorine so disposal could potentially be challenging and expensive.

190. In adhesives and sealants, it was estimated that 250 million cans (containing 750 ml of one component foam (OCF) product) are produced per year in the EU, with an estimated market value of approximately €250 million. Based on results of the ECHA market survey, it has been estimated that the prices of affected products would increase between 10-13% (assuming an average price of €8 per 750 ml can of OCF and €4.50 per kg of insulating glass sealants (IG)). The total consumer cost was estimated at €3.5 billion over the 20-year time period.

191. In the rubber sector, the impact assessment relied on information provided to the ECHA by companies producing rubber conveyor belts. Some of these companies are already substituting MCCP-containing components. It was estimated that each company would have to test 5-10 products to verify product compliance, at a one-off cost of €6,000 – 30,000 per product. A variable cost of replacing MCCPs with more expensive alternatives (LCCPs) was estimated at a cost of €3.9 million per annum. The total transition cost for the sector was estimated to be €54 million over a 20-year period.

192. In metal working fluids, a ban on manufacture and placing on the market is expected to lead to the additive suppliers, producers of metal working fluids and the metal working sector incurring profit losses (estimated at €1 billion over a 20-year period). In this case, a 2-year transition period is expected to be too short of a time to transition. If a derogation is applied, the metal working fluid industry is expected to shift to alternatives over a 7-year period. A longer transition period has been proposed here to allow the industry to undertake necessary research and development to substitute MCCPs. This was identified by the ECHA market survey where sector specific stakeholders indicated that a transition period between two and ten years (on average six years) would be required to substitute MCCPs in the remaining metal working applications. The one-off costs of reformulation and testing were estimated at approximately €90 million for the producers of the metal working fluids, and the changes in annual operating conditions were estimated at €12 million. The total costs of this scenario were estimated around €200 million over a 20-year period.

193. In paints and coatings, based on an estimated 50 companies in the EU being impacted by the restriction, the total costs for a restriction were estimated at €10 million. This assumed each company may incur testing costs of around €200,000. Due to the added value and protective properties of coatings it was considered by ECHA (2022) that coating producers will be able to transfer substitution costs to customers/clients.

194. MedTech Europe have highlighted that substituting MCCPs with alternatives in medical devices and IVD (*in vitro* diagnostic) medical devices would incur costs for compliance analysis, supplier communications, and the testing and qualification of substitutes (MedTech Europe, 2020). Further costs could occur if a complete redesign of products were required. The transition costs estimated by MedTech Europe Members were 0.7-10% of revenue/turnover for medical devices and 0.1-0.6% for IVD medical devices. Due to the critical application of medical devices in the healthcare sector, MedTech Europe have recommended up to 10 years for complex medical devices and 8 years for IVD medical devices as an appropriate timeline for substituting MCCPs.

195. In Canada, the metal working fluids and other sectors may incur reformulation and increased operating costs due to higher costs associated with alternatives (Canada, Annex F submission). In their Annex F submission (2022), the WCC-CPIA shared information provided by industry in the USA. In 2015, the US Department of Defence stated in a letter to US EPA that MCCPs have critical military applications in metal working fluids (WCC & CPIA, Annex F Submission). As discussed above in section 2.3, the ASC in the USA indicated the lack of drop in replacements for MCCPs for use in adhesives and sealants in the construction sector, with the concern that no replacement has yet been identified to provide sufficient flame retardancy. In 2016, in a letter to US EPA, the American Wire Producers Association stated that "if CPs become unavailable in the US for use in wire drawing lubricants, manufacturers will be unable to continue some or most of their operations" (Idem). In 2016, in a letter to US EPA, the Aerospace Industries

Associations required extended time and information in order to identify any potential initiatives for many of the applications where MCCPs are used (Idem).

196. Temporary or permanent closures of production sites would lead to loss of business and revenue, production or sales of MCCPs. This could result in a reduction in employment of companies manufacturing MCCPs. Previous estimates by KEMI (2018) have referred to five companies representing 70% of the total EU PVC market, operating 41 production plants located in 21 different sites. These operations were estimated to have a total of 7,000 employees (although it was noted in the study that not all of these can be connected to PVC containing MCCPs). It could be that an increased demand for MCCP alternatives could lead to a change of distribution of employees between manufacturers, at least in the medium to long term.

197. ECHA has predicted that the restriction of MCCPs would present no major impact on employment in the EU if appropriate transition times are given (ECHA, 2022). It is however recognised that there could be some negative impacts on the producers of products containing MCCPs, as a lower output of products could result in job losses. However the identification of both technically and economically feasible alternatives could result in the hiring of new employees for the new products during a transition period, which would compensate any potential layoffs.

198. None of the companies in the EU PVC sector that have already phased out substances with MCCPs (or that are in the testing phase of alternatives) have presented loss of employment. There are no job losses anticipated in the paint and rubber sectors. However, job losses might occur in the metal working fluid sector under certain restriction options (those involving a ban on manufacture and/or placing on the market). There are currently no alternatives available for the products where MCCPs are used for the sector, and the transition period would not provide enough time to find any reliable alternatives. In the case of a ban with a 2-year transition period, production of certain products in the metal working fluid sector where no alternatives are available are expected to halt and potentially put employees' jobs working in those areas at risk.

Movement towards sustainable development

199. A restriction on MCCPs could result in a drive to shift to environmentally safer alternatives.

200. The SCCPs RME has noted that elimination of SCCPs would be consistent with the Strategic Approach to International Chemicals Management (SAICM) whose Global Plan of Action is to support risk reduction that include prioritising safe and effective alternatives for persistent, bioaccumulative and toxic substances (UNEP/POPS/POPRC.12/11/Add.3). As MCCPs are considered bioaccumulative, persistent and toxic, elimination of MCCPs would also be consistent with SAICMs Global Plan of Action.

2.6 Other considerations

Access of information and public education

201. In Sweden information about hazardous substances (including MCCPs) is available from the Swedish Chemicals Agency[56]. A publicly open access tool named PRIO has also been developed by the Swedish Chemicals Agency to help companies to detect and substitute hazardous substances in products and articles that they handle[57]. Monitoring information of MCCPs is also available through the Swedish Environmental Protection Agency[58].

Status of control and monitoring capacity

202. Several existing EU/EAA annual monitoring programmes have been highlighted in the EU's (2022) Annex F submission. This included Norway where several monitoring programmes have been undertaken in a range of different matrices, including air, precipitation, terrestrial and urban environment, Fjords, rivers, sediments and human biomonitoring[59].

203. The Norwegian Environment Agency (NEA) has conducted a study based on samples from MISA (Miljø i svangerskapet og i ammeperioden), a human biomonitoring study (HBM) from Northern Norway focusing on POPs

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[56]https://www.kemi.se/en/chemicals-in-our-everyday-lives/advice-on-chemical-smart-choices/your-right-to-information)

[57]https://www.kemi.se/prioguiden/english/start/background---prio

[58]https://www.naturvardsverket.se/om-miljoarbetet/miljoovervakning/programomraden/luft/organiska-miljogifter

[59]https://www.miljodirektoratet.no/ansvarsomrader/overvaking-arealplanlegging/miljoovervaking/overvakingsprogrammer/forurensning-og-klimagasser/

which included MCCPs[60]. Screening of chlorinated paraffins in air, fish, mammals, bird eggs and pine needles are summarised in a report by the Nordic Council of Ministers 2022[61]. Also, several monitoring studies have been undertaken in Sweden investigating chlorinated paraffins in other environmental matrices, such as sediment cores, offshore sediments, fish, and moose (Sweden Annex F 2022 submission). Another study investigated chlorinated paraffins in human milk and serum from China, Sweden and Norway. Additionally, the Swedish Chemicals Agency has undertaken market surveillance, focusing on toys, e-commerce products, and high visibility clothing, to identify where MCCPs are present. The Swedish National Food Agency has also undertaken a "Swedish market basket sample" as a first attempt to estimate intake of chlorinated paraffins from food (Sweden Annex F 2022 submission).

204. In the UK, the National Chemicals Investigation Programme (NCIP) is a series of investigations into the occurrence, sources and removal of trace substances from wastewater works. UK Water Industry Research (UKWIR) in collaboration with the Environment Agency have set out the basis for these studies which commenced with CIP1 in 2010 and continue with the CIP 2 and CIP 3 terminating in 2025. As part of this work, samples were taken at around 30 locations to monitor the concentrations of substances of emerging concern (including MCCPs). It was indicated from this monitoring that waste water treatment plants resulted in decreased concentrations (effluent compared to influent) of 46-96% for MCCPs (mean removal of 86%)[62].

205. Canada has three funded research projects on MCCPs conducted under Canada's Chemicals Management Plan (2022-2024) (Canada Annex F 2022 submission). These include developing methods to analyse MCCPs and LCCPs in air, studying the presence of MCCPs in a range of environmental matrices (including water, sediment, and biota), and applying new approach methodologies to investigate the toxicological effects of MCCPs and LCCPs. MCCPs are also being measured in the blood serum of a nationally representative sample of Canadians aged 20-79 years under the Canadian Health Measures Survey (CHMS) cycle 7, 2022-2024. Other monitoring programmes under Canada's Chemicals Management Plan include monitoring in various biota, including in birds and fish. Additionally samples of ringed seal blubbers are also being analysed for CPs under the Northern Contaminants Program.

206. As discussed in Section 2.3, analytical challenges have been highlighted as a potential concern for quantifying MCCPs in environmental samples. As discussed in the risk profile (UNEP/POPS/POPRC.18/11/Add.3), the vast majority of monitoring studies whether of biota, sediment, soil or air matrices are limited to the detection of "MCCP" congeners with only 5–10 chlorine atoms. This is linked to the reference standards used as well as analytical limitations (Kraetschmer et al., 2019).

207. The Risk Profile (UNEP/POPS/POPRC.18/11/Add.3) provides an extensive overview of previous and contemporary monitoring activities.

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[60] https://www.miljodirektoratet.no/publikasjoner/2021/mars-2021/persistent-organic-pollutants-pops-in-human-samples-from-the-misa-study-northern-norway/

[61] https://www.norden.org/en/publication/screening-chlorinated-paraffins-dechloranes-and-uv-filters-nordic-countries

[62] https://ukwir.org/the-national-chemical-investigations-programme-2020-2022-volume-5-substances-of-emerging-concern?Email_Campaign_Mail=2127359

3 Synthesis of information

3.1 Summary of risk profile information

208. At its eighteenth meeting in 2022, the POPs Review Committee adopted the risk profile and decided that MCCPs are likely, as a result of their long-range environmental transport, to lead to significant adverse human health and environmental effects, such that global action is warranted.

209. The risk profile (UNEP/POPS/POPRC.18/11/Add.3) notes that following national and international restrictions on the use of SCCPs (including listing under the Convention), the supply of MCCPs has increased significantly as the main drop-in replacement. This increase in supply, and consequent environmental emissions, is reflected in the levels of MCCPs in environmental samples, with multi-year sampling of sediment cores indicating a decline in SCCPs with a concurrent increase in MCCPs in layers representing more recent years.

210. Available evidence indicates widespread occurrence of MCCPs in surface water, sediment, soil, biota, sludge, and air, in multiple regions of the world, including remote regions. MCCPs can also be widely detected in wildlife including predators, as well as human tissues. The concentrations detected in wildlife in more contaminated areas show that high levels can be found in organisms. MCCPs have been detected in a range of market foods, household dust, household products and appliances, playing fields and other sources that may represent important human exposure pathways. As the switch from SCCPs to MCCPs has only occurred in recent years, the concentration of MCCPs in the environment can be expected to increase in the absence of risk management.

3.2 Summary of risk management evaluation information

211. While MCCPs have come under increased regulatory scrutiny due to environmental and health concerns, with control actions being proposed or considered in the EU, Norway, Canada, UK, and the USA, MCCPs are not currently banned at national level, and MCCPs are not currently covered by international conventions.

212. Continued production of MCCPs has been reported in China, India, Japan, Europe, USA, and Qatar. A notable shift in the geographical distribution of global production and use of MCCPs has been observed in recent decades. Until around 2000, production and use of MCCPs had predominantly occurred in North America and Western Europe, but since then a rapid increase in production and use in Asia (China and India) has been observed and currently China dominates in terms of global volumes for production and use of MCCPs. Peak levels of production and use were reported in around 2014, since then volumes have started to decline.

213. Differences between volumes of production and use of CPs between global regions indicates the net transboundary trade, for example with China and India exporting CPs (as well as CP-containing articles) to other regions, while Japan, South America, and Africa import CPs from other regions (Chen et al., 2022). It is also expected that the international trade of products likely containing MCCPs (e.g. electronic equipment, PVC-containing materials) from China and India to other global regions (e.g. EU, USA) can also result in MCCPs entering the market, and ultimately the environment.

214. In comparison with the manufacturing process in North America and Europe, where CPs are manufactured using distinct paraffin feedstocks with specification-controlled chain lengths, i.e to produce SCCPs, MCCPs and LCCPs, according to the CP industry (WCC, pers. comm., 2022), the technical CP products used in China are generally not characterised by carbon chain length but by chlorination degree (Chen et al., 2022). This means that no individual MCCP or SCCP-containing products are available in China, and the technical CP products in use are mixtures of CPs of all chain lengths. In addition, LCCP-containing products may contain a significant proportion of $C_{16–17}$ CPs in various concentration levels up to ca.20 %, when the feedstock to produce 'LCCPs' predominantly consists of carbon chain lengths C_{18-20} (ECHA 2022).

215. MCCPs are still currently being used in a range of commercial and industrial applications. The main uses identified in this risk management evaluation are in PVC, in metal working fluids and as additives to paints, adhesives, sealants, rubbers and other polymeric materials. A key functionality identified for MCCPs in PVC and rubber is the dual function of plasticiser and flame retardant, and in metal working fluids MCCPs are used in extreme (high temperature and pressure) conditions. The predominant users of MCCPs vary between different countries and regions. For example, in Western Europe and China, use of MCCPs is predominantly in PVC and adhesives/sealants, while in North America and Japan, use is predominantly in metal working fluids.

216. Relatively recent assessments of alternatives for MCCPs (for example by ECHA, 2022; Danish EPA, 2014) have reported that while available alternatives have been identified for each of the main uses described above, the feasibility of substitution/removal (and by extension the associated costs) may differ between different specific uses. For PVC, technically feasible alternative substances or technologies are available, however it is noted that one single substance may not be able to substitute the MCCPs across all its uses since MCCPs can function as both plasticiser

and flame retardant. For adhesives and sealants, it was highlighted that CPs impart critical flame-retardant properties to building and construction applications. For metal working fluids alternatives appear to be available, although it is not certain whether they are technically able to replace MCCPs in all heavy duty/extreme (e.g. high temperature and pressure) working operations.

217. A number of potential uses of MCCPs, where exemption may be needed, have been highlighted by Parties and Observers through the Annex F submissions, including uses in military/defence, aerospace and automotive applications (WCC/CPIA, ACEA, ICCAIA, CCPIA, Japan 2022 Annex F submissions), as well as electric and electronic equipment used for medical practice (such as clinical, diagnostic, inspection, analysis, monitoring and others) and industrial and other types of monitoring, control, analysis and measurement equipment, in laboratories, infrastructures of transportation, lifelines, security, disaster preventions, and process control (Japan Annex F submission).

218. For applications where alternatives are available, some potential economic impacts have been highlighted, relating to increased costs associated with raw material costs, reformulation, compliance analysis, supplier communications, and testing and qualification of alternatives. For example, for metal working fluids, Canada (Annex F submission) noted that available alternatives may not be technically suitable for all applications and may be more costly as they are expected to incur reformulation costs, as well as increased operating costs. The assessment by ECHA (2022) highlighted that a ban on MCCPs would likely lead to significant economic impacts to businesses and downstream users, particularly if a temporary cessation of production or product sales results from the loss of technical function and/or availably of alternatives. Furthermore, for MCCPs that are used in several important applications, a discontinuation of production combined with a lack of suitably available MCCP substitutes could potentially have impacts on key applications and sectors important in society (e.g. aerospace, defence and medical application have been raised by Parties and Observers).

219. A key concern regarding the appropriate risk management of MCCPs is related to the substantial volumes of waste containing MCCPs and the quantity of MCCPs released to the environment during waste management. The EU (2022, Annex F submission) indicated that 71-84 % of the total releases of MCCPs to the environment in Europe are due to ultimate disposal of articles and materials containing MCCPs as waste. With the observed rapid increase in production and use of MCCPs observed in the last ~20 years, this issue is expected to become more challenging in future years.

220. The variety of different uses for MCCPs, and types of products they are incorporated into across different sectors presents different challenges for safely handling and disposing of waste. In some areas (e.g. North America, Japan) uses of metal working fluids are dominant. In others (e.g. Europe and China), use in PVC products and adhesives/sealants dominates, where the CPs are largely integrated into the product and their relative long service life (up to several decades) mean that the potential environmental impact from ‘in use stocks’ could continue for many years to come, even if use of MCCPs was halted. While control measures preventing environmental release may be more feasible at production sites, polymeric products are more likely to be disposed of in landfill, potentially acting as a long-term reservoir for release the environment.

221. The presence of MCCPs in LCCP commercial products is expected. However this is not interpreted in this risk management evaluation as ‘unintentional production’ but is considered as ‘unintended presence’ in the product. The carbon chain length distribution of a CP product is reflected by the carbon chain length distribution of the parent hydrocarbon feedstock, which is controlled by the producer. In Europe ECHA is proposing a concentration limit of 0.1 % (w/w) for restricting the presence of chloroalkanes with $C_{14–17}$ chain lengths with PBT and/or vPvB properties in CP commercial products. Based on the input from the CP industry (CPIA/WCC, pers. comm, 2022), limiting the ‘unintentional presence’ of MCCPs in other CP products in this way may be more feasible in the USA and EU but may present more of a challenge in Asia (e.g. China and India) – where the bulk of production is now occurring – as indicated in earlier sections, according to the CP industry (WCC, pers. comm., 2022), they do not base production on feedstock chain length rather the viscosity/chlorine content.

222. Listing MCCPs under the Convention is expected to result in benefits to human health, the environment, agriculture and biota. It is noted that the total cumulative emissions currently estimated for MCCPs, and the potential future emissions associated with in-use stocks, is substantially greater than many POPs currently listed under the convention. While not currently controlled under nation-level legislation, the negative health impact of MCCPs to human health have been recognised at the national (Canada, Annex F submission) and international (ECHA, 2022) level. Listing MCCPs under the Convention would also reduce occupational exposure. It is not possible to quantify the benefits of eliminating or restricting MCCPs; however, they are considered to be significant given the costs associated with the significant adverse effects on human health and the environment that are likely to result from the continued production and use of MCCPs.

3.3 Suggested risk management measures

223. Consistent with Decision POPRC-18/4, MCCPs warrant global action to control their production and use to eliminate their release and build up in the environment. [The most appropriate control measures as agreed by the POPRC are outlined below]

Annex A without specific exemptions

224. From the perspective of protecting human health and the environment, the preferred option is to list MCCPs in Annex A (Elimination) to send a clear signal that production and use of this POP substance should be phased out where alternatives can be used. This listing would eliminate production and use and result in significant emission reductions following the entry into force of the control measure. Furthermore, this listing would both eliminate MCCPs and further reduce unintentional SCCPs (already listed as a POP under the Convention) in new articles, as it has been established that SCCPs could be present as residual components of other CPs (see UNEP/POPS/POPRC.12/4).

225. It is indicated from the information submitted by Parties and Observers, as well as analysis and modelling studies in the literature, that the overall global production volumes of CPs have started to decline in recent years. Some key regions that had produced CPs in large volumes (e.g. EU, USA) have significantly decreased their production volumes in the past 25 years. This could be an indication that alternatives for most major uses of CPs in general, and MCCPs specifically, are available and substitution is ongoing. Furthermore, available evidence from countries that have already started to phase out MCCPs and where action is planned to restrict or prohibit use of MCCPs at national or international level (e.g. see ECHA, 2022), suggests that a transition away from MCCPs in most uses is expected to have limited negative economic impacts on society, however the transition from MCCPs to alternatives is expected to have impacts for specific industries across the main uses for MCCPs in Europe. The socio-economic impacts in other markets (e.g. Asia) have not been investigated in as much detail.

226. However, it is considered that a phase out of MCCPs in Europe would be feasible for most uses within 2 years after the foreseen entry into force of the restriction under REACH. For metal working fluids, however, a longer (7 year) transition period was considered, as alternatives for more extreme (pressure and temperature) conditions have not yet been identified. However, it should be noted that EU (2022, Annex F submission) report that ECHA recognises that the derogation/7-year transition period for metal working fluids, as currently proposed in the Annex XV, is not specific enough to set clear boundaries for this derogation. ECHA may therefore consider removing this derogation/transition period unless sufficient and substantiated information is received.

227. Prohibition of the production and use of MCCPs would reduce and eventually eliminate releases of MCCPs to the environment (over a long period of time, given ongoing releases from existing PVC, rubber and plastic articles in use). The full life cycle impacts of all alternatives compared with MCCPs have not been investigated for all uses and alternatives. In some cases, it has been indicated that the overall life cycle impacts of alternatives could be greater than that of MCCPs.

228. [insert concluding statement]

Annex A with specific exemptions

229. Respondents to the Annex F call for information have highlighted a number of uses they consider ‘critical’. This includes uses within aerospace and defence (ICCAIA, WCC-CPIA, AECA, CCPIA) and uses within the automotive sector and medical applications (Japan). In both cases the argument relates to the safety critical nature of the industry sector, strict regulations on chemical and article performance, and long lead-in times for substitution. Additionally, regulatory processes at national/regional level (Canada and European Union) identified that there may be specific issues for the phase-out of MCCPs within a sub-set of metal working fluids (relating to high temperature and extreme pressure applications such as deep drawing and broaching, etc).

230. [insert concluding statement]

231. Based on the available information, specific exemptions for applications in these sectors may be considered:

(a) For uses in PVC

- Uses in aerospace/defence and automotive sectors – for specific applications where flame retardancy is needed to ensure safety standards.
- Uses in medical applications – electrical and electronic equipment (such as clinical, diagnostic, inspection, analysis and monitoring).
- Uses in building/construction – applications for monitoring, control, analysis and measurement equipment in laboratories, transportation infrastructure, lifelines, safety, disaster prevention and process control

(b) For uses as extreme pressure/temperature additive in MWFs

- Uses in aerospace/defence and automotive sectors – for the production of specific metal parts - using the following materials: stainless steel, titanium or nickel alloy e.g. fasteners for aircraft and jet engines, including nuts, bolts, latch pins, and rivets) as well as fuel lines, brake line and hydraulic systems; production of specific spare parts.

(c) For uses in adhesives/sealants

- Uses in aerospace/defence, automotive and building/construction sectors – specific applications where flame retardancy is needed to ensure safety standards.

232. A listing within Annex A with specific exemptions would therefore need to consider control measures that minimise emissions to environment as far as possible, and promote the adoption of safer alternatives as soon as possible. The use of specific exemptions would also mean the continued manufacture of MCCPs to meet the demand for these specific uses and industry sectors.

233. Therefore, where specific exemptions might be used, the adoption of further control measures is likely to be needed. Firstly, during the manufacture of MCCPs, suitable levels of control of emissions and management of wastes (particularly to wastewater) are needed (with further details provided in Section 2.3). Secondly, during the manufacture of articles that contain MCCPs (particularly PVC and rubber) suitable levels of abatement and waste management practices should be adopted. Finally, for in-use articles containing MCCPs, a form of labelling scheme or easy identification would help to avoid accidental mismanagement of wastes. This could cover continued new use or manufacture of replacement parts. In several sectors, particularly where articles are already in use, for example PVC-containing cables, adhesives and sealants ending up in construction waste, this could be very challenging.

Annex B (with acceptable purposes)

234. Listing MCCPs in Annex B would allow for acceptable purposes. Consistent with the requirements of paragraph 6 of Article 3 of the Convention, listing MCCPs in Annex B with acceptable purposes, or specific exemptions, would require parties to take appropriate measures to prevent or minimise human exposure and releases into the environment. Requirements for control of discharges and emissions could take various forms, and ideally would target all stages of the life-cycle where emissions may occur.

235. However, while some parties and observers have expressed concerns regarding the current technical feasibility and availability of alternatives to MCCPs in some key applications, it is noted that the concern appears to be largely related to the availability of feasible alternatives that can act as a direct ‘drop-in’ replacement covering all functionalities of MCCPs together.

236. [insert concluding statement]

Annex C

237. Listing MCCPs in Annex C of the Convention could be considered in order to control the *unintentional production* of MCCPs during the manufacture of other CP mixtures. A listing of MCCPs on Annex C would require Parties to address only the MCCPs within the scope of the listing description “when formed and released unintentionally from anthropogenic sources”. However, as outlined in this risk management evaluation, the potential occurrence of MCCPs congeners in the scope of this proposal, in CP commercial products that are outside the scope of this proposal (e.g. LCCPs) is not interpreted as being ‘unintentional production’ and this may be better controlled through specifying a concentration limit on the presence of relevant chloroalkanes in commercial CP products (as was previously recommended for the listing of SCCPs).

238. [insert concluding statement]

4 Concluding statement

239. Having decided that Chlorinated paraffins with carbon chain lengths in the range C14–17 and chlorination levels at or exceeding 45 per cent chlorine by weight are likely, as a result of long-range environmental transport, to lead to significant adverse effects on human health and the environment such that global action is warranted; Having prepared a risk management evaluation and considered the management options:

240. The Persistent Organic Pollutants Review Committee recommends, in accordance with paragraph 9 of Article 8 of the Convention, that the Conference of the Parties to the Stockholm Convention consider listing of Chlorinated paraffins with carbon chain lengths in the range C14–17 and chlorination levels at or exceeding 45 per cent chlorine by weight under [Annex A to the Convention] [with] [without] specific exemptions [] [and under Annex C].

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